MECHANICAL ENGINEERING

• MARCH 1952 •

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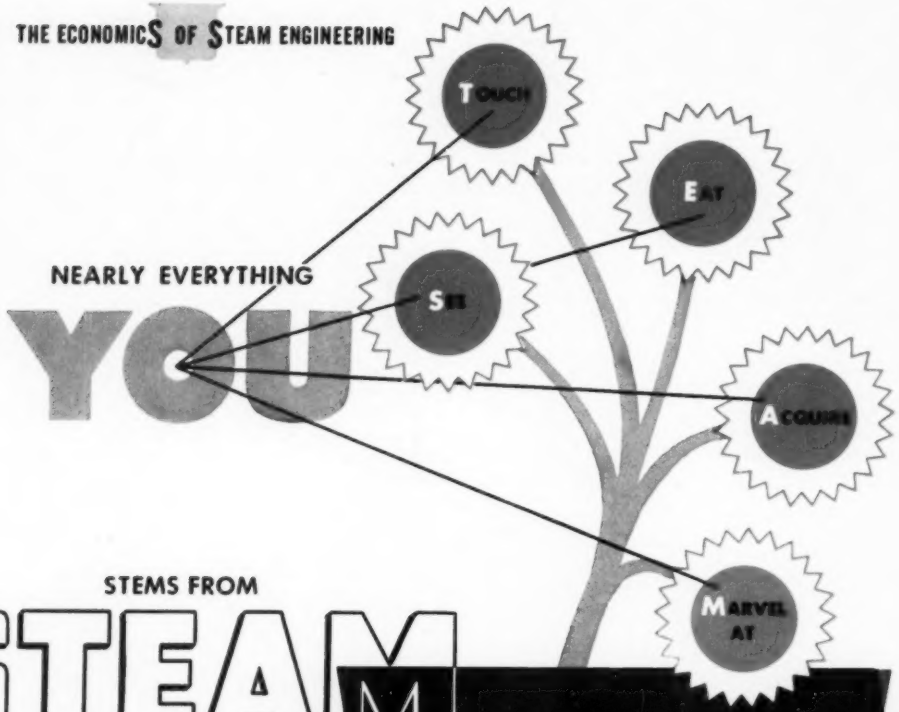
THE ECONOMICS OF STEAM ENGINEERING



STEMS FROM

STEAM

Modern low-cost steam is a driving force behind your daily comfort and convenience, helping in hundreds of ways to give you the best values . . . the highest standards of living . . . you'll find anywhere in the world.

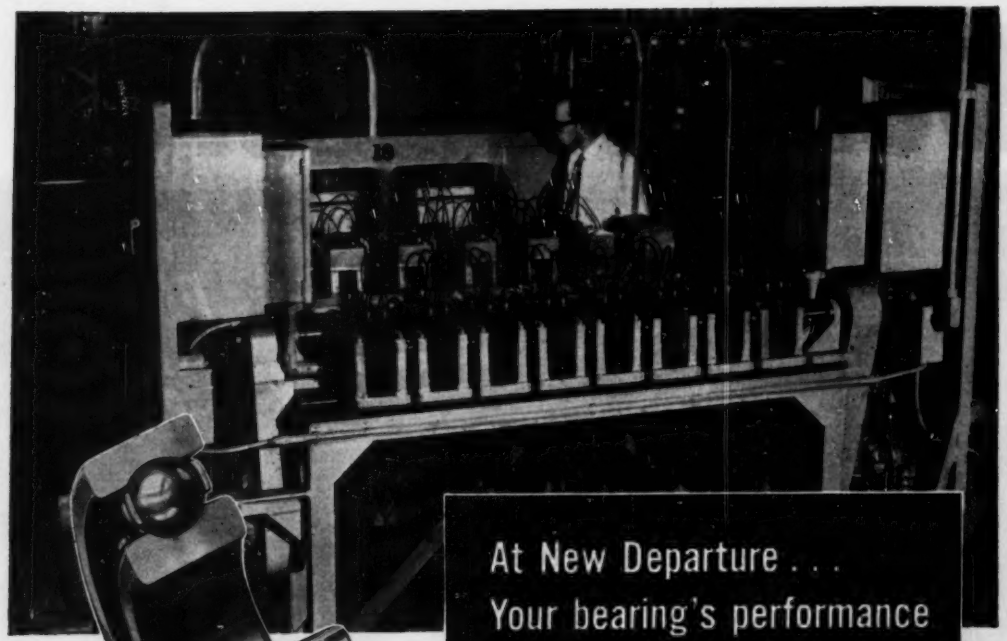
Since the days of "Fulton's Folly," and before, steam has provided a versatile and economical basic force which, translated into human terms, has warmed our homes, processed most of the things we eat and wear and use, transported us from place to place on land and sea, and made slaves of thunderbolts chained to the nearest wall-socket.

Practical engineers with the capacity to dream have been molding steam like putty for a good many years—physicists, mechanical engineers, metallurgists, civil engineers, chemists and all the rest—men intent on developing new and better ways to make and use steam. They will continue to achieve so long as Btu remains a symbol to which you add Imagination to derive a formula of Accomplishment, for the benefit of all mankind.

Progressive, resourceful engineering is a 75-year tradition at B&W, where men of vision who thrive on challenge blend skill and imagination to advance steam engineering and the many other industrial activities they serve.

BABCOCK & WILCOX

G-553



At New Departure . . .
Your bearing's performance
is tested and proved
before you use it

Considering the big part ball bearings must play in the efficient operation of your machine, it is important for you to *know*, and in *advance*, how the bearings will perform.

For example, you need to know what results may be expected from each type of grease under varying conditions.

Supplying you with this information is just one of the functions of New Departure's new and ultra-modern engineering laboratory.

To help you get the answers:

What is the determining factor of seal-bearing life?

How operating conditions contribute to metal fatigue?

Which has the most effect on grease life—speed or load?

Lubrication selection.

. . . a monograph, "Grease Lubrication of Ball Bearings," by New Departure's Manager of Research, Development and Design, will be mailed upon request. 163

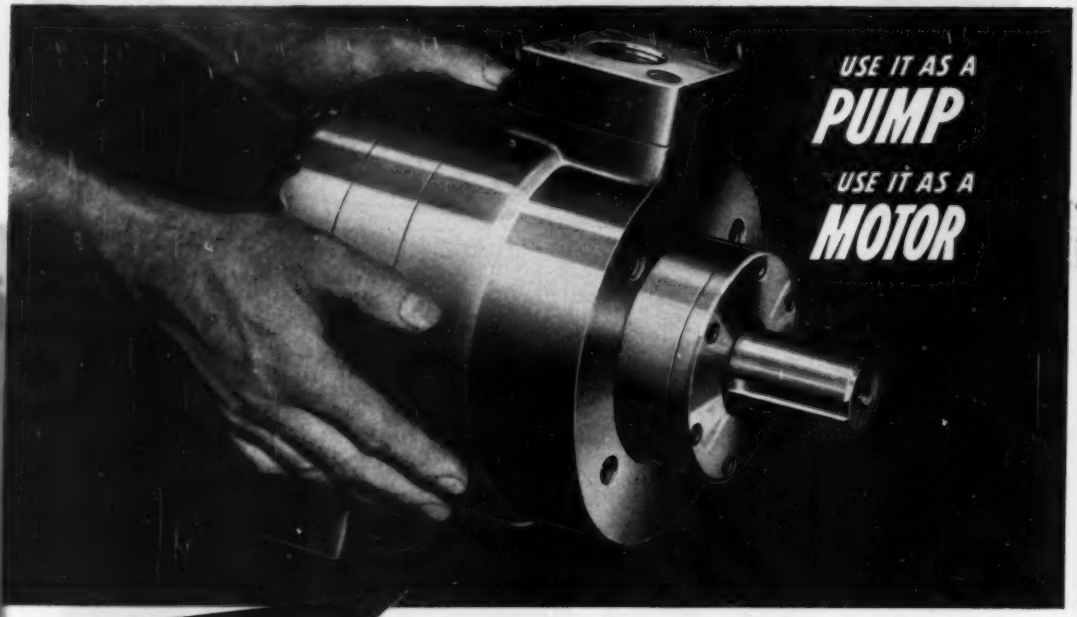
Nothing Rolls Like a Ball . . .

NEW DEPARTURE
BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS
BRISTOL, CONNECTICUT

MECHANICAL ENGINEERING, March, 1952, Vol. 74, No. 3. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.

Denison scores



A Few Denison FIRSTS

1944 Multipress . . . self-contained oil hydraulic production tool offering a new concept of wide-range adaptability and control.

1946 5000 psi relief, sequence and unloader valves. Hydraulically balanced . . . closer control.

5000 psi constant volume pumps . . . heavy duty, high volumetric efficiency.

1948 5000 psi variable-volume pumps for handwheel, cylinder, stem or pressure compensator control of pump volume.

1950 5000 psi surge-damping controls in both aircraft and industrial models.

5000 psi pilot-operated directional controls . . . positive action regardless of pressure.

THREE popular sizes . . . Built for 2000 psi continuous duty . . . Ready for use as either pump or motor without alterations of any kind in the unit itself . . . Clockwise or counter-clockwise operation as either pump or motor . . . 5 to 60 gpm pumping capacities . . . 380 to 4600 inch-pounds torque capacities as a motor . . . Hydraulically balanced vane action, with dual sealing edges contacting cam ring . . . Meets 16 different porting and directional requirements as either pump or motor . . . Face, flange and foot mountings . . . Rugged, space-saving compactness plus two-way efficiency!

DENISON Hydr Oil ics

another FIRST

NOW

a single-stage 2000 psi

Dual Purpose Vane-Type Oil Hydraulic Pump

"The Finest Money Can Buy!"

Denison adds another important *first* to a long list of new and improved products and ideas in the oil-hydraulic field. This all-new, radially balanced hydraulic power unit works equally well as a pump or as a fluid motor! No changes of any kind have to be made in the unit itself. *Think of the advantages in being able to stock one type of unit for both pump and motor needs!*

In addition the new unit offers either clockwise or counter-clockwise rotation—for either pump or motor applications.

The unit is built in three sizes, each offering interchangeable cam rings for various volume or torque requirements — providing eight different pump or motor capacities in all.

As a pump — the 8 models have volume capacities from 5 to 60 gpm and are capable of operating continuously at 2000 psi.

As a motor—the 8 models have torque capacities from 19 to 230 inch-pounds per 100 psi and are capable of operating continuously at 2000 psi.

As a pump or a motor — the unit provides positive, constant displacement—even at low speeds. Vanes are hydraulically balanced for smoother action, longer life, less wear.

Cantilever support for the shaft and bearing assures rigid support for external shaft loads, and minimizes the effect of misalignment. Pressure-equalization reduces surge and pulsation of oil delivery to a minimum.

Simplicity is the key to the versatility, compactness and efficiency of this new pump/motor, making it a worthy addition to the long line of "firsts" by Denison.

Write for Bulletin P-5 today! *It gives full details on this unique, dual purpose HydrOILic Pump/Motor.*

The DENISON Engineering Co., 1189 Dublin Rd., Columbus 16, Ohio

A Statement by Anaconda on the Copper Situation

MANY users of copper have vital decisions to make . . . usually in connection with the present defense-induced shortages of copper and aluminum. This statement is an effort to remove the smoke screen surrounding the copper picture . . . to wipe away the confusion caused by too much talk supported by too few facts.

Substitution poses problems – Industry has been urged to substitute aluminum and other materials for copper. In some instances this may be logical and practicable. In many others it is difficult, if not impossible. But – before making *any* long-term decisions that may cost a great deal of money in engineering, new plant facilities or rescheduling of production operations – one should know the facts about the future of copper.

New Anaconda projects – The first major increase in copper production will come from Anaconda when the Greater Butte Project and the new Sulphide Plant at Chuquicamata, Chile, begin operations this spring. By 1953, these two projects should raise present levels of copper production by about 95,000 tons yearly.

Toward the close of 1953, Anaconda's new Yerington project in Nevada is expected to start producing at an annual rate of 30,000 tons. By then, Anaconda will be adding to the present yearly copper supply at the rate of about 125,000 tons.

Other new projects – During 1954-55 still other new projects in the U. S. and friendly foreign countries will further augment the increasing copper supply. All told, it is estimated that by 1955, not less than 450,000 tons of copper could be produced annually – over and above present production levels.

Accordingly, in 1955-56, domestic production plus imports could bring the U. S. copper supply to 1,800,000 tons yearly. This would represent an increase of about 20% over present levels. Based on historical comparisons, and barring a large-scale shooting war, this amount of copper could support a Federal Reserve Board Index of Industrial Production of 270, an increase of 24% over the present, and 45% above the first half of 1950.

• • •

These are the 'things to come' in copper. On the basis of the facts there is no necessity for considering long-range substitution of other materials for the red metal.

523284

ANACONDA
COPPER MINING COMPANY

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Anaconda Wire & Cable Company
International Smelting and Refining Company
Andes Copper Mining Company
Chile Copper Company
Greene Cananea Copper Company

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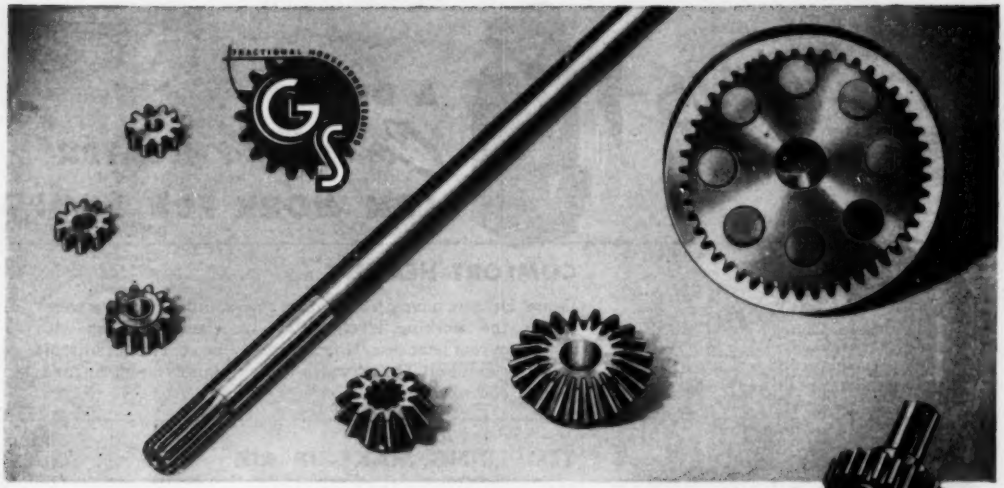

LAUSON Outboards Give Top Performance with G.S. Small Gears

"Completely engineered for trouble-free operation"..that's what The Lauson Company, of New Holstein, Wisconsin, says about their newest Model T-651R, 6 H.P. Twin Outboard Motor. Only components uniformly manufactured to the highest precision standards can assure the *consistent* trouble-free operation of this rugged new Lauson Twin. G.S. is pleased with the privilege of making the Fractional Horsepower Gearing for a motor of such excellent quality. We welcome the responsibility of helping Lauson to maintain a 50 year reputation for building better engines.

If you, too, have a quality product in which *better* Small Gears are involved, you can depend upon G.S. for the kind of cooperation you need. Let our highly specialized skills and facilities go to work for you NOW. Will you write for a demonstration of G.S. service today?

SEND FOR..

free new 6-page folder illustrating and describing G.S. facilities, Small Gearing and applications, together with handy charts. Will you ask for it on company stationery, please?

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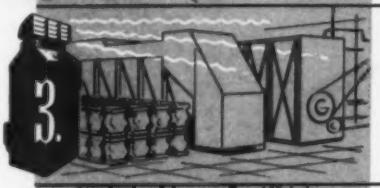
COMFORT HEATING *(commercial and industrial)*

Dravo Heaters have a 150-foot air throw and recirculate warm air at the working level, giving maximum comfort with minimum roof heat loss. No expensive pipe covering, radiators or ducts required. Quick warm-up; automatic on-off or modulating controls.

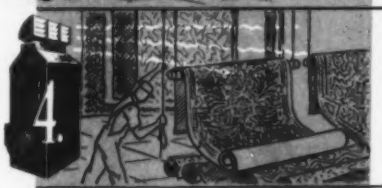
TEMPERING MAKE-UP AIR

Where dust-filled or fume-filled air must be removed from a building by exhausters, this air can be replaced and tempered by Dravo Heaters. Equal pressure is maintained . . . working conditions are kept comfortable.



HEAT CURING

Dravo Heaters can be used independently or in combination with other equipment for process curing concrete, plastics, paper, fibre containers, rubber and many other products. Automatic temperature controls keep air flow at desired temperature.



PROCESS DRYING

Moisture content of air can be controlled or removed entirely by using fresh or recirculated air. Immediate response to temperature controller demand makes it ideal for drying paint, farm crops, wood products, rugs (after cleaning) and many other processes.

YEAR-'ROUND VENTILATION

In addition to comfort heating, Dravo Heaters provide fresh-air ventilation in warm weather and can be easily tied in with air-conditioning systems.

DRAVO HEATER *Plus* VALUES . . .

- **Low initial cost . . . users report 30% to 60% savings on installation.**
- **Direct-fired . . . low fuel consumption . . . burn gas or oil . . . readily converted.**
- **Long service life, low maintenance . . . stainless steel combustion chamber eliminates refractory lining.**
- **Easily moved to any location to fit your requirements.**
- **Flexibility . . . can be mounted horizontally or vertically on floor, walls or ceiling.**

WRITE FOR MORE INFORMATION. It's worth your while to look into Dravo *Counterflo* Heaters for any of these five functions shown above. You'll be glad you did. Ask for Bulletin No. ST-526-02

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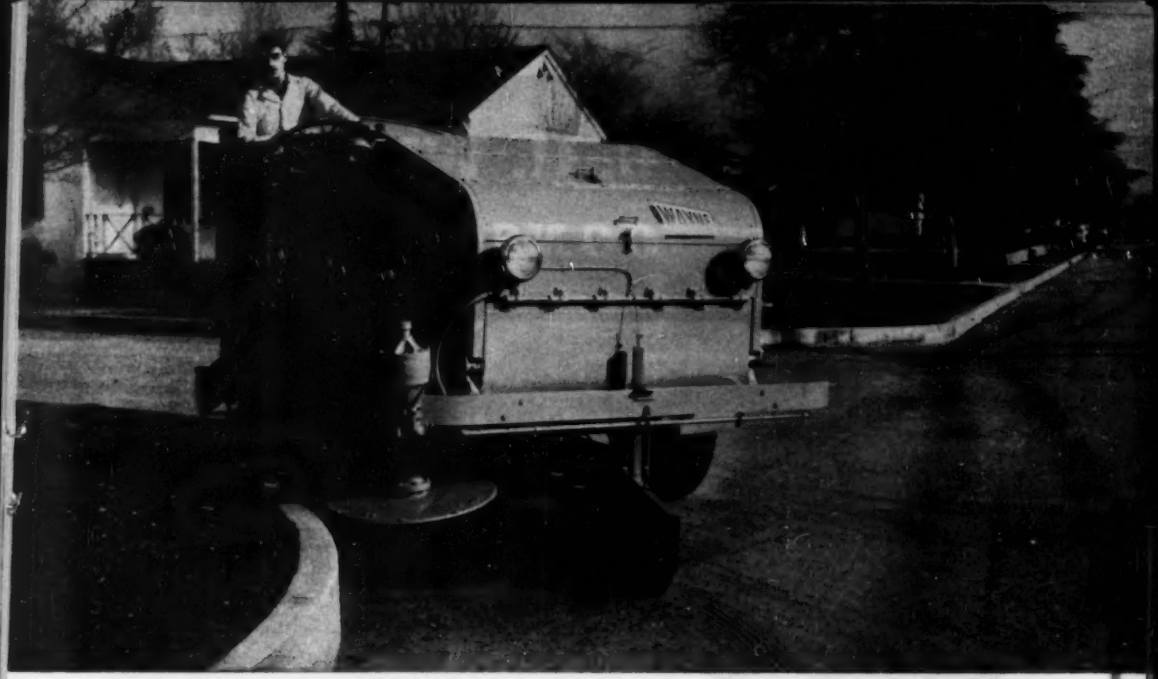
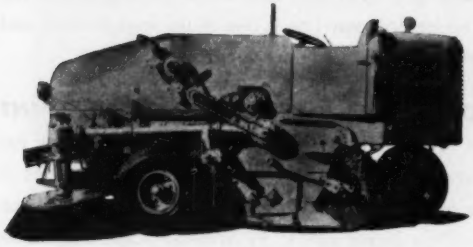
Sales Representatives in Principal Cities

Manufactured and sold in Canada by Marine Industries, Ltd., Sorel, Quebec

Export Associates: Lynch, Wilde & Co., Washington 9, D.C.





How heavy-pitch Morse Chains answer this sweeping challenge

Fleets of Wayne Pick-Up Sweepers are used by the Navy, Army, and Air Force and by over 200 cities (New York alone using 71) to make streets sparkling clean for pennies per mile. In model shown above, hopper capacity is over 84 cubic feet of sweeper-moistened dirt and litter, which sweeper carries at truck speed to central dumping ground. The work is punishing, but this quality-built machine stands up to it.

Power transmission

Heavy-pitch Morse Roller Chains transmit power from four-speed transmission to front wheels. Other Morse Chains drive street-to-hopper dirt conveyor and rear pickup broom, supply power to forward gutter broom.

The Morse Chains operate with 99% efficiency on both long and short centers. They give long, efficient life; require minimum of service. Morse Chains contribute materially to the Wayne Sweeper's reputation for exceptional performance at low operating cost.

If you are faced with unsolved power transmission problems, look into the reliability, economy and efficiency of Morse Roller Chain Drives. Or perhaps your need is for some other power transmission product in the famous Morse line of clutches, flexible couplings, drive shafts, silent chains, double-pitch roller chains, or cable chains. Let us send you information on the application you have in mind.

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MECHANICAL
POWER TRANSMISSION
PRODUCTS

M = PT Morse *means* Power Transmission

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C. H. WHEELER & *CONSOLIDATE TO*

Economy Pumps, Inc. and C. H. Wheeler Manufacturing Company have consolidated engineering and manufacturing facilities in C. H. Wheeler's plant at Philadelphia. Facilities are now being expanded through new construction and the installation of additional modern machine tool equipment.

PUMPS . . . Economy has for many years been among the leaders in the engineering and manufacture of centrifugal, axial and mixed flow pumps. Today, the Wheeler-Economy line is one of the most modern and complete in the pumping industry.

CONDENSERS & POWER PLANT EQUIPMENT . . . The C. H. Wheeler Manufacturing Company has contributed many of the outstanding developments in the field of condensing apparatus and vacuum problems. Nearly a decade ago, C. H. Wheeler adopted Economy mixed flow pumps for use with their condensers.

PROCESS EQUIPMENT . . . C. H. Wheeler is also internationally known for Cooling Towers, Steam Jet vacuum apparatus and Fine Particle Reduction Mills, vital links in modern chemical and food processes. Wheeler-Economy Pumps will round out the company's services in these fields.

MARINE GEAR . . . C. H. Wheeler's Marine Gear, Condenser and Deck Machinery department will be augmented by Wheeler-Economy Pumps designed for marine application.

42-inch Wheeler-Economy Vertical Mixed Flow Pump for condenser circulation. 32,500 G.P.M.

ECONOMY PUMPS, Inc.

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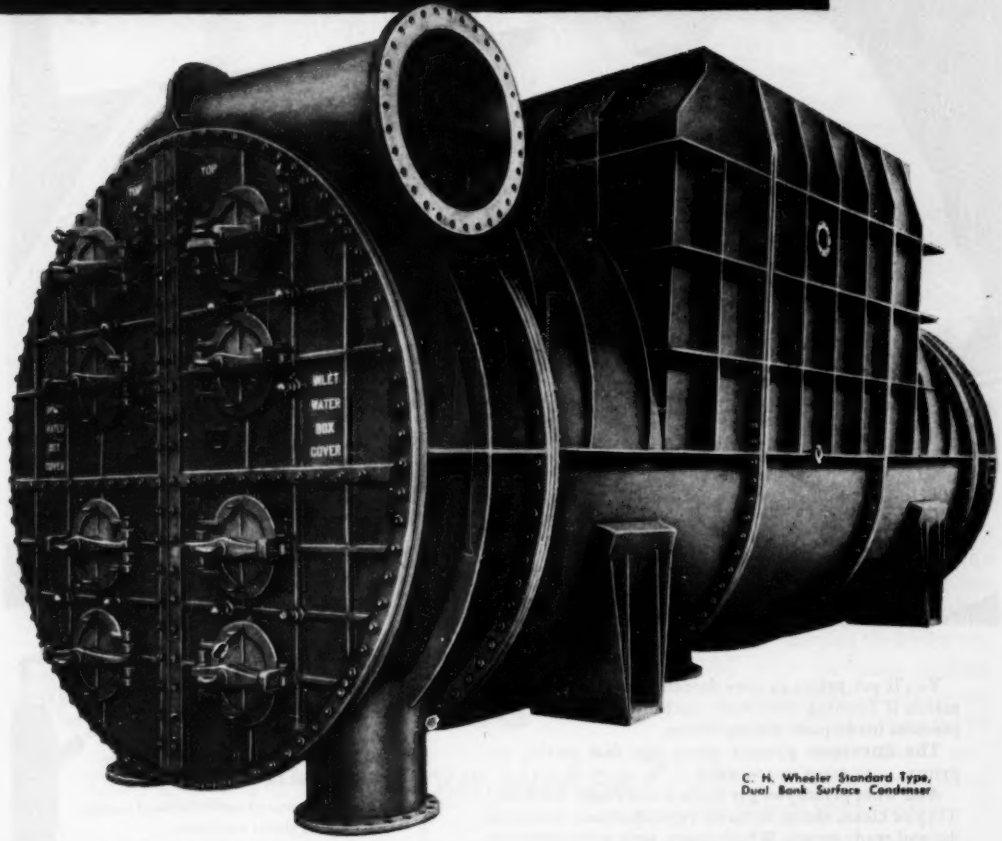

C. H. Wheeler Standard Type, Dual Bank Surface Condenser

WHEELER-ECONOMY PUMPS

. . . a new name combining old names that have been known and respected for generations. All the experience and metal working techniques this consolidation brings together are of great importance to you — our customer. Wheeler-Economy Pumps will fill your every requirement regardless of size or problem involved. Write to Philadelphia or to the nearest Economy or Wheeler representative listed in the phone directories of principal cities.

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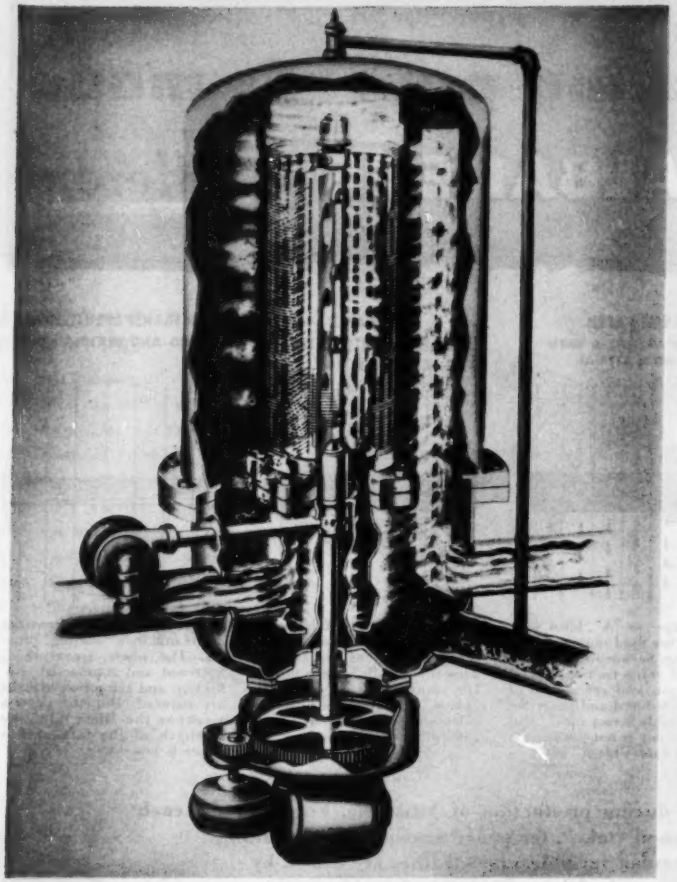

How many times do you re-use your water?

Cut water *waste* and water *bills*. Make used process water fit for re-use by running it through a Cuno FLO-KLEAN strainer. Also—a low-cost way to clean raw river or lake water for industrial use.

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Fluid Conditioning

Removes More Sizes of Solids from More Kinds of Fluids

Strain fuels, lubricants, process fluids, etc.—AUTO-KLEAN
Filter fuels, lubricants, process fluids, etc.—MICRO-KLEAN
Clean raw water, recirculating water, etc.—FLO-KLEAN

Works without Attention to Furnish Clean Water —Cheap

This is the way many industrial plants solved the problem of high water bills and low water supplies.

They use Cuno FLO-KLEAN Strainers to remove trash from raw water . . . or to reclaim used process water.

Some users have saved enough to pay for their FLO-KLEANS in a few months!

The FLO-KLEAN is a large-capacity (up to 20,000 gpm), corrosion- and abrasion-resistant strainer which positively removes all solids larger than specified.*

Continuously Self-Cleaning

Operation is continuous—with never a stop for cleaning the FLO-KLEAN. This eliminates the need for a duplex installation.

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So—with continuous cleaning of the cartridge and automatic top and bottom blow-down, there's nothing to worry about. FLO-KLEAN can be installed in some remote place and forgotten.

*May be specified from .030 in. down to .0025 in.

Cuno Engineering Corporation
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Please send information on Cuno FLO-KLEAN for straining raw water..... reclaiming process water....

Name..... Title.....

Company.....

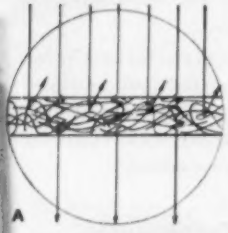
Address.....

City.....Zone....State.....

Please attach to business letterhead

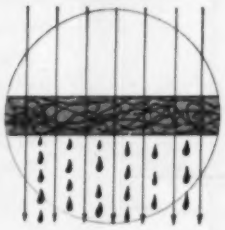
ALBANENE*

TOUGH, LONG-FIBER PAPER
NOT TRANSPARENTIZED



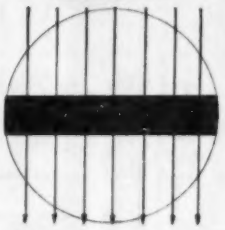
Diagrammatic enlargement of cross section of paper with high strength but low transparency. Fibers are surrounded by air, which has different index of refraction. Many light rays are bent back and do not get through.

SAME PAPER
TRANSPARENTIZED WITH FLUID MATERIAL



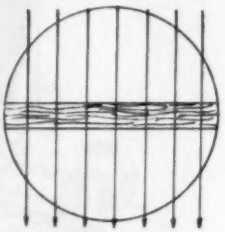
Same paper as "A", filled with oil or other fluid material, giving spaces between fibers same index of refraction as fibers. Reflection and refraction of light are reduced and paper becomes highly transparent. But transparency is not permanent because *fluids* "bleed" out.†

SAME PAPER
TRANSPARENTIZED THE ALBANENE WAY



Same paper as "A", filled with an inert synthetic resin, with correct index of refraction. This is how Albanene is made. Its transparentizer does not "bleed" out. Albanene holds its color and strength and is permanently transparent.†

PAPER TRANSPARENTIZED BY
CRUSHING AND BEATING FIBERS



Papers are also transparentized at the mill by a "beating" process. The fibers are crushed, flattened and compacted. Reflection and refraction of light are reduced. But the process weakens the fibers and the strength of the transparent paper is low.

More than 15 tests are made during production of Albanene. For example, each production roll is tested for pencil "take", for pencil erasing and the taking of drawing ink. To eliminate human variables, pencil lines are drawn by machine. In this way you are assured of the uniformity of working surface so much desired by draftsmen, and assured of a paper that makes cleaner, sharper prints . . . now or a generation later. Ask your K&E Distributor or Branch for further information.

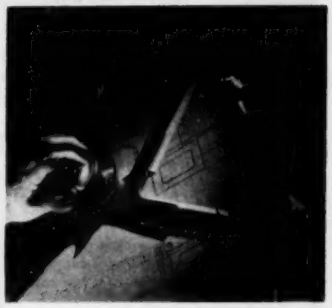
† Prove this by making the "drafting tape test" Press a short piece of drafting tape on fluid-transparentized paper, and another on Albanene. Strip them off the next day and examine both papers. Notice that enough fluid has drifted out of the ordinary paper into the tape to destroy much of the transparency. And notice that Albanene is not affected. What drafting tape does over night, time will do naturally.

*TRADE MARKS ®

The Right Angle

AVAILABLE IN MANY FORMS FOR MANY USES

Albanene comes in 20-yard and 50-yard rolls in various widths and in three different weights. For those who like the convenience of cut sheets, a new Albanene package has been designed. It strongly protects the paper in shipment and storage, and may be opened without mutilating the container, thus serves as a dispenser in drafting room or stock room. Albanene cut sheets can be supplied imprinted to your specifications.



Once you've discovered the pleasure of drawing on Albanene, the next logical step is to save time, trouble and eyesight with a K&E PARAGON* Drafting Machine. You control your calibrated straight edge with a light touch of one hand, for parallel lines and lines at any angle.

Make your lettering letter-perfect and save wear and tear on your nerves by using a LEROY* lettering outfit. Template grooves guide your pen so the finished result looks like printers' type, and the whole process is relaxing. There's a wide choice of sizes, styles and symbols.

K+E

1

Care and Maintenance of Chains—Suggestions on how to get better service with less maintenance from your conveyor and drive chains.

2

Rex® Lumber Mill Chains—Complete descriptions with photos of all Rex Chains used in the lumber, pulp, and paper industries.

3

Rex Oil Field Chains—Rex and Baldwin-Rex® Oil Field Chains and other oil field products pictured and described.

7

Rex Chains for Cement and Rock Products Industries—A description of Rex and Baldwin-Rex products used in these industries. Includes chain, idlers, conveyors, bucket elevators.

8

Rex Pressed Steel Detachable Chain—A complete range of quality chains for drive and conveyor service where loads are light and speeds slow.

9

Rex and Baldwin-Rex Conveyor Chains and Attachments—Describes and illustrates various types of conveyors that can be constructed from our complete line of chains and attachments.

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a gold-mine of useful information

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Chain Belt product literature is designed especially with you in mind. Informative, concise, easy to read, these bulletins contain the information that's bound to be helpful to you in solving your problems in connection with power transmission, conveying and process equipment.

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Rex Stock Sprockets—Rex Sprockets, carried in warehouse stock for over-the-counter sales, cataloged by chain type and size.

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Rex Chains for Every Drive and Conveyor Service—A highly condensed, "ready-reference" booklet on the complete Rex and Baldwin-Rex Chain line.

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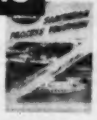
Rex Belt Conveyor Idlers—Complete descriptions of all types of Rex Belt Conveyor Idlers, including information on proper application.

15 

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Rex Roto-Brush Can Cleaner and Drier—Describing a new and efficient method for fast washing and drying of most sizes of cylindrical cans.

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Baldwin-Rex "BA" Riveted Roller Chain—Describes new riveted roller chain assembly with single pin connector for ease of assembly and disassembly.

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Baldwin-Rex Double-Pitch Roller Chains—Facts on how you can cut costs and reduce weight by specifying Baldwin-Rex Double Pitch Roller Chain.

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Baldwin-Rex Stock Roller Chains—Complete specifications, prices and descriptions of Baldwin-Rex Roller Chains, Couplings and Sprockets.

28

A Quick Look at Chain Belt—The story of Chain Belt Company in capsule form . . . with plenty of pictures showing history and product application.

Chain Belt Company, Advertising Dept. 52-400
4765 West Greenfield Ave., Milwaukee 1, Wisconsin

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How would YOU solve these two problems?

VISCOSITY CONTROL is important to Fuller Brush manufacture. Special sealing compound makes their handles stay put. It's applied by expensive equipment. If the equipment is started before the compound is fluid, the automatic machinery will be severely damaged. Now a *low-cost* Fenwal THERMOSWITCH thermostat prevents damage by starting the motor *only* when viscosity is right.

SPOILAGE FROM OVER-HEATING would prove costly to egg producers if water in Peden's Whirl-A-Way egg washer got too hot. Accurate temperature control, under extreme moisture conditions, was called for. Only a temperature-sensitive, adjustable, moisture-proofed Fenwal THERMOSWITCH thermostat installation met *all* the requirements at reasonable cost.

A FENWAL THERMOSWITCH CONTROL may solve your problem, too. Its external single-metal shell expands or contracts *instantly* with temperature changes, making or breaking enclosed electrical contacts. Compact, hermetically sealed, highly resistant to shock and vibration, Fenwal THERMOSWITCH units have solved hundreds of problems.

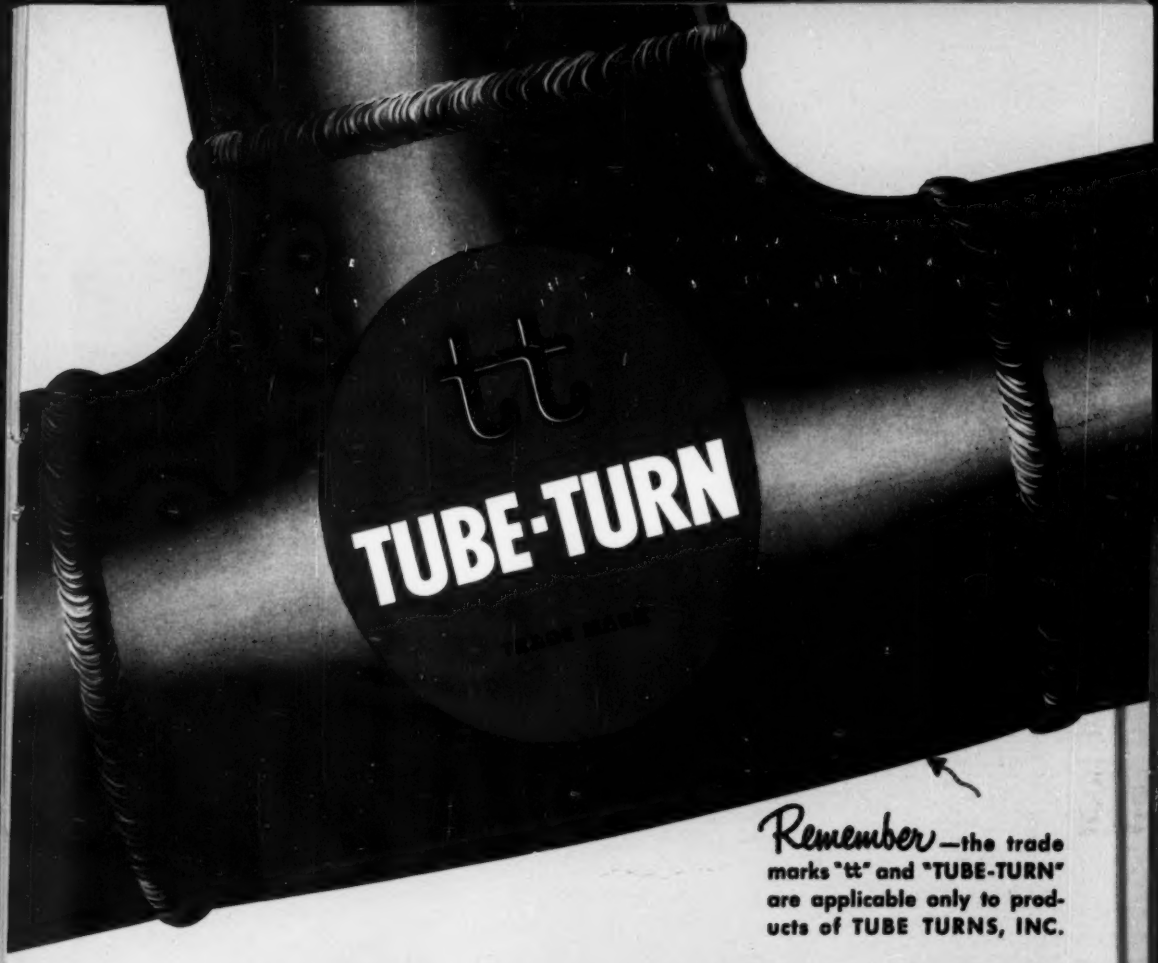
SEND FOR THIS NEW CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, vapor level, radiant heat, pressure and other variables. Write Fenwal, Incorporated, Temperature Control Engineers, 53 Pleasant Street, Ashland, Mass.

Fenwal

THERMOSWITCH®

Electrical Temperature Control and Detection Devices

SENSITIVE... *but only to heat*



Remember—the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

Engineered to cut maintenance manhours

Scrappy says, "Aid defense—more scrap today... more steel tomorrow."

Write Dept. F-3 for free booklet on Allowable Working Pressures. Use coupon on reverse side.

CONSIDER THIS when you specify welding fittings for permanent, leakproof piping . . . the kind that's maintenance-free:

TUBE-TURN Welding Tees are drawn from seamless tubing to a barrel shape—the form every tee wants to assume under pressure. This feature, and the generous crotch radius and thickness, explain why TUBE-TURN Welding Tees withstand more pressure than required. Bursting pressures obtained in tests of representative fittings have averaged over 25% higher than required by standard codes.

For this extra quality at no extra cost get in touch with your nearby TUBE TURNS' Distributor. You'll find one in every principal city.

Be sure you see the double "tt"

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

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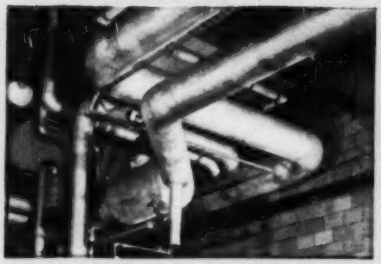
TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO... A wholly owned subsidiary of TUBE TURNS, INC.

Servel, Inc. specifies piping permanence with TUBE-TURN Welding Fittings

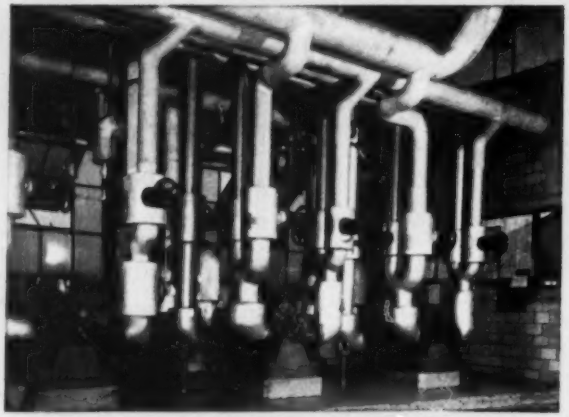
THE EXTENSIVE piping systems which serve the modern 70-acre Servel plant, in Evansville, Indiana, carry steam, condensate, air, water, acetylene, ammonia, hydrogen, oxygen, and natural gas—*efficiently*.

To avoid leakage and downtime for piping repairs, Servel engineers specify the use of TUBE-TURN Welding Fittings and Flanges for all lines 2 inches and up. Thus maintenance expense is cut to the bone. The welded system also conserves space, and provides optimum flow conditions.

Such efficiency in production services has played a large part in the growth of Servel, Inc., makers of the famous Servel gas and electric refrigerators and a variety of other products.



With no flanges to work around, insulation was easily applied to welded steam lines. Joints will not leak, and insulation will last.



These 2½", 3", 6", and 8" lines for return water pumps and water booster pumps are fabricated with TUBE-TURN Welding Fittings. Close-fitting welded piping is compact and neat.

Steel blanks for cartridge cases are washed in this tank prior to forging operation. Time was saved in tank construction by fabricating heating coils with 1½" TUBE-TURN Welding Returns. Dimensional accuracy assured perfect line-up.

Careful quality control is demonstrated by this spectrographic analysis, made of every TUBE-TURN alloy Welding Fitting before pickling, passivating, and shipping. This check, one of many, assures that user's specifications are met.

TUBE TURNS, INC., Dept. F-3
224 East Broadway, Louisville 1, Kentucky

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• *No other member of the turtle family (in fact no other living creature) can match the life expectancy of the species inhabiting the waters of the Galapagos Islands. Average life: 300 to 400 years.*

1st in long life expectancy

In the field of bearings, too, looks can be misleading. Don't buy them on the principle that "look-alikes" must necessarily "last-alike."

Safer way is to look for the name AETNA on the bearings you buy for replacement in the equipment you use—to specify AETNAS when blueprinting a brighter future for the equipment you make. Indicative of their quality and lasting serviceability is the fact that 80% of our business comes from firms we have served for 20 or more of our 36 years.

Aetna

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings

AETNA BALL AND ROLLER BEARING COMPANY
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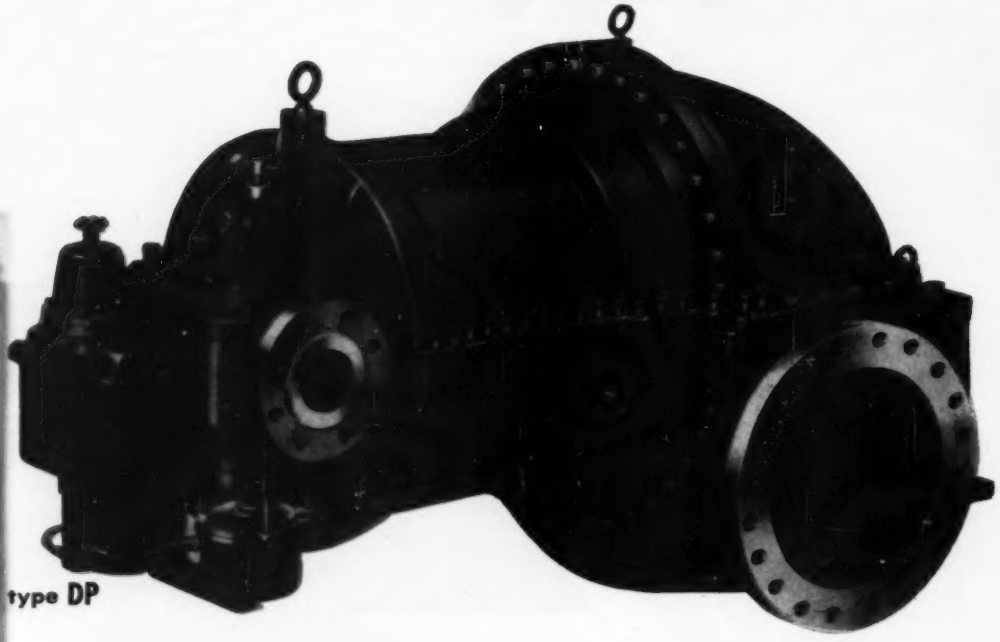
General Electric Announces

A NEW ADVANCE IN



type DP

Custom Performance from Standard Turbine Drives now possible through new Designs and Manufacturing Methods

Now you can select the mechanical-drive turbine that will give you maximum mechanical power for your fuel dollar . . . and without the delay and expense of special engineering. General Electric's four new multi-stage drives are *standards*, designed to meet your *specific* requirements.

Four new governing systems give you a wide selection of performance ratings. A new sectional valve gives you greater efficiency for part load operation. Many other improvements make these the finest turbines of their size General Electric has ever produced.

Secret of their adaptability is in the method of manufacture. By using interchangeable casting patterns, designed to be combined in a variety of ways, it's possible for the factory to "customize" standard machines for individual applications. You get a better turbine, designed for your job, and the delivery time is shorter, the cost lower.

Get the full particulars on these new multi-stage turbine drives. Write for our new bulletin, GEA-5580, "G-E Multi-Stage Turbine Drives." General Electric Company, Section 252-53, Schenectady, N. Y.

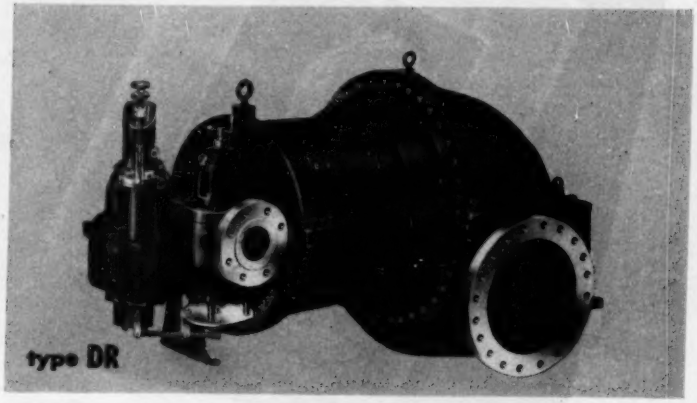
GENERAL ELECTRIC

252-53

MULTI-STAGE TURBINE DRIVES

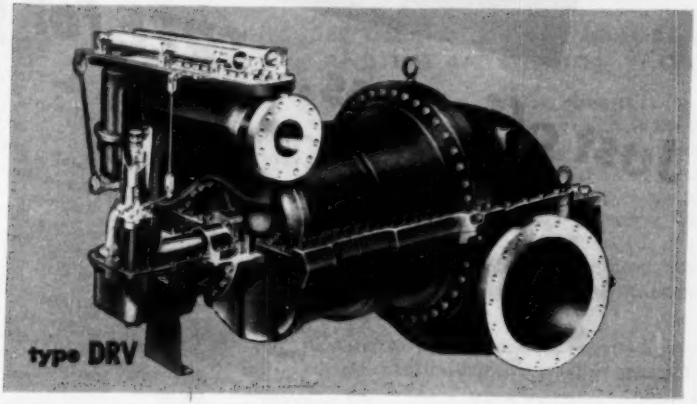
type DP

Dependable power over a 30 per cent adjustable speed range.



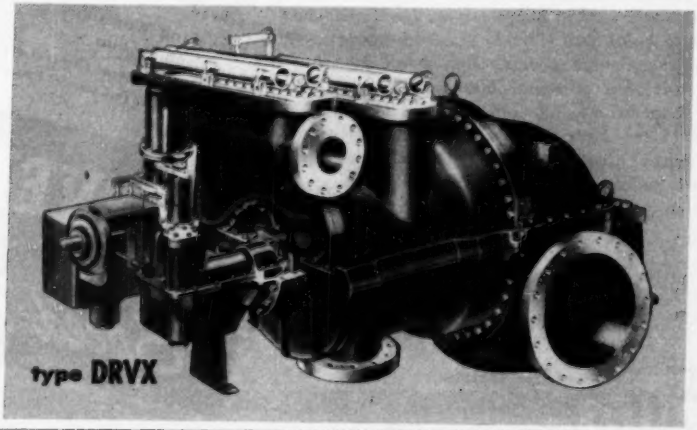
type DR

Oil-relay governor makes possible a speed range of 6 to 1, with only 4 per cent regulation and ½ per cent steady state speed variation.



type DRV

Automatic sectional valves linked to the oil-relay governor minimize throttling losses under fluctuating load factors, make possible substantial operating savings.



type DRVX

For applications where process steam is desired at a definite, steady pressure. Extracted steam pressure remains constant even when load on the unit fluctuates and the flow of extracted steam varies.

Whether you want one worm-gear speed reducer or a thousand, a standard drive or a unit designed to meet your special problems, Cleveland is prepared to serve you. Meeting the most difficult requirements of machinery manufacturers and users is Cleveland's everyday business.

Just off press... FREE for your asking

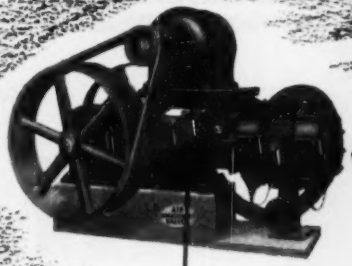
YOU'LL find first aid in this new Cleveland catalog — whenever you have to select worm gearing or an efficient worm-gear speed reducer.

Catalog 400 replaces our old Catalog 200. Its 180 pages illustrate and describe each model in the complete line of Cleveland Worm Gear Speed Reducers. It contains engineering data on each type, including dimensions, weights and horsepower capacities—all the information you need to arrive at proper selections of drives for any equipment.

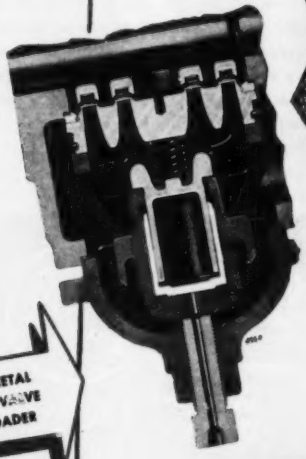
Over a year in the making, Catalog 400 is now available to all our customers. If you can use one in your work of designing power-driven equipment, or selecting speed reducers for new or old machines, just drop us a line on your letterhead.

The Cleveland Worm and Gear Co., 3264 East 80th Street, Cleveland 4, Ohio.

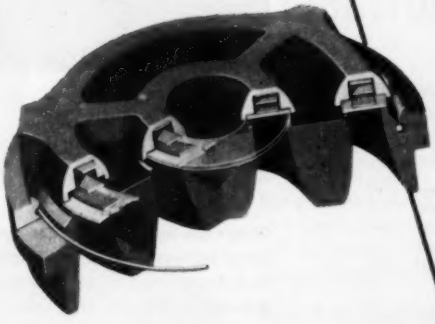
Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.



Look at The HEART of This PENNSYLVANIA COMPRESSOR . . .



ALL METAL INLET VALVE UNLOADER



AIR CUSHION VALVE

SEE THE INLET VALVE UNLOADER AND THE AIR CUSHION VALVE

Quality of design simplicity appears in these two basic Pennsylvania features. Note the inlet valve unloader, of all-metal construction. There are no diaphragms or packing to require frequent replacement as is so commonly the case with diaphragm type unloaders. The unloader is continuously tight seated, effective sealing being accomplished through the seating of the moving plunger on a ground level seat.

Renewal of parts is seldom required; even adjustment of the unloader is rarely necessary.

The Air Cushion Valve contains nothing to easily break or get out of order. There is a complete absence of bolts that could freeze fast or break and damage the compressor. Air cushioning contributes to quietness of operation and long life. Valve discs made of the highest grade stainless steel, are of the annular flat plate type subject to no flexing or bending. Valve springs, also of stainless steel, are rolled on edge, gaining maximum strength and durability.

FEATURES

- Simplicity
- No Diaphragms
- Durability
- Quietness
- Long Life
- Easy to Assemble
- Easy to Disassemble
- No Bolts

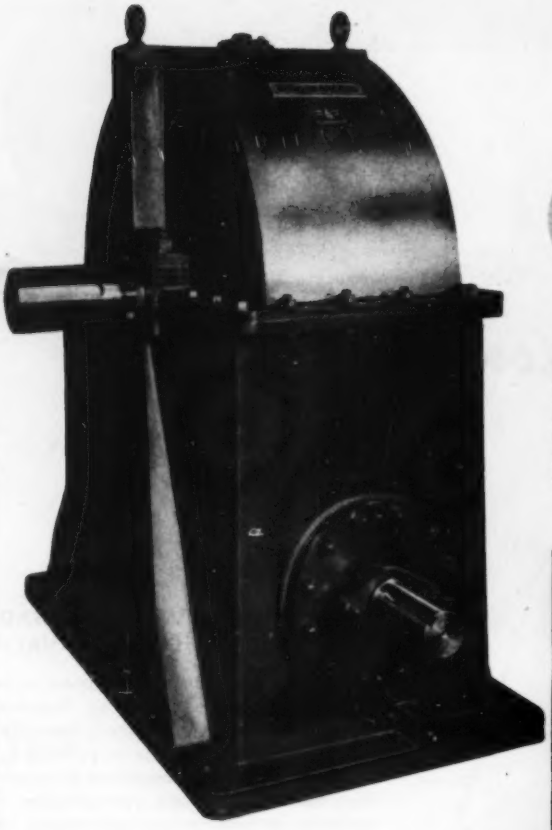
AIRCHEK VALVES

PENNSYLVANIA

THRUSTFRE PUMPS

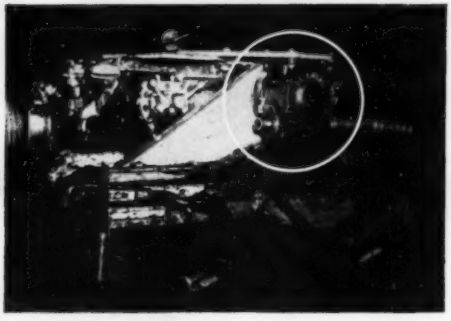
PPC

We build'em all sizes at De Laval



Giant

Take a look at this 30" center distance worm gear speed reducer! As far as we know, it is the *largest* standard enclosed drive unit ever built. It's doing a big job, too, on a large Mesta Machine Co. slabbing mill for a prominent steel company. A twin of this giant is scheduled for a new eastern mill.



FREE

Easy-Selection Manual

Is there a quick way to select the right reducer for your application? Yes, new De Laval Manual G-WBV makes it simple as ABC. It contains complete selection data, hp rating tables and outline drawings . . . all set up in easy-to-use form. Write for your copy today.

Dwarf

Here's one of the smaller De Laval worm gear speed reducers with a 3" center distance. It is being used by the Crichton Company, Johnstown, Pa. for their new coal drilling machine. Big, small or in-between, De Laval heavy duty worm gear reducers are proving profitable investments for scores of machinery manufacturers throughout the country.

DE LAVAL *Speed Reducers* ***Built to be Built-into a Quality Product***

DE LAVAL STEAM TURBINE COMPANY • TRENTON 2, NEW JERSEY

DL-105

the best-made

plans

are made with **Turquoise** containing

100% *"Electronic" Graphite!

Unmatched smoothness! "Electronic" is Eagle's trade name for a blend of purest crystalline graphites reduced to micronic fineness in our patented Attrition Mill. Leads made with it 100% have a frictionless, smooth-gliding quality never approached before.

Non-crumbling points! The microscopic graphite particles of infinitely varied, close-interlocking shapes combine with the clay binder to form the strongest, longest-wearing lead structure ever made.

Perfect reproduction! Because millions more of these finer graphite particles are compacted in every inch of its lead, Turquoise deposits denser, blacker, even lines that reproduce to perfection.

Precision grading! 17 individual, exactly controlled formulas of Electronic graphite and clay keep the 17 degrees of Turquoise evenly spaced and as true as a plumb line.

Free Sample: Write for a free sample, naming this magazine, your dealer, and the grade you desire.

*®

EAGLE PENCIL COMPANY • NEW YORK • LONDON • TORONTO

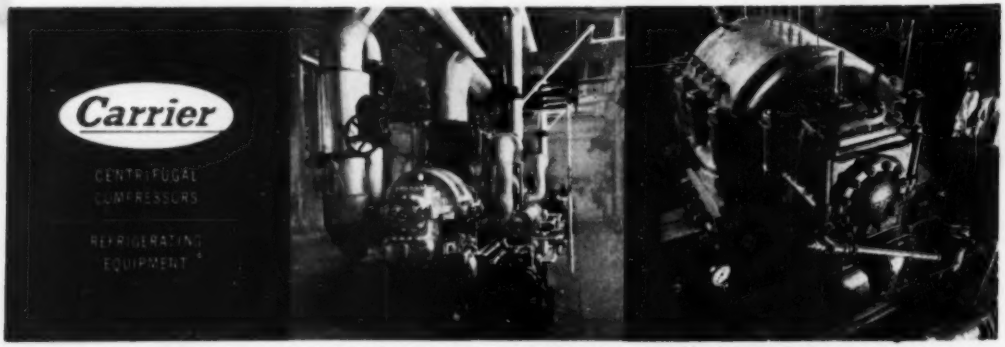
Is there a gas we haven't met?

Our Carrier Centrifugal Compressors have compressed more different gases on the job than those of any other manufacturer. We think experience like that is important to you.

Maybe you work with butane or propane. Ethylene, methylene chloride, ethane or chlorine. Air, oxygen, sulphur dioxide or hydrogen sulphide. All of these and many more have been used in our Centrifugal Compressors at some time or other during the past thirty years. So there's a lot of experience for you to draw upon when you call on Carrier.

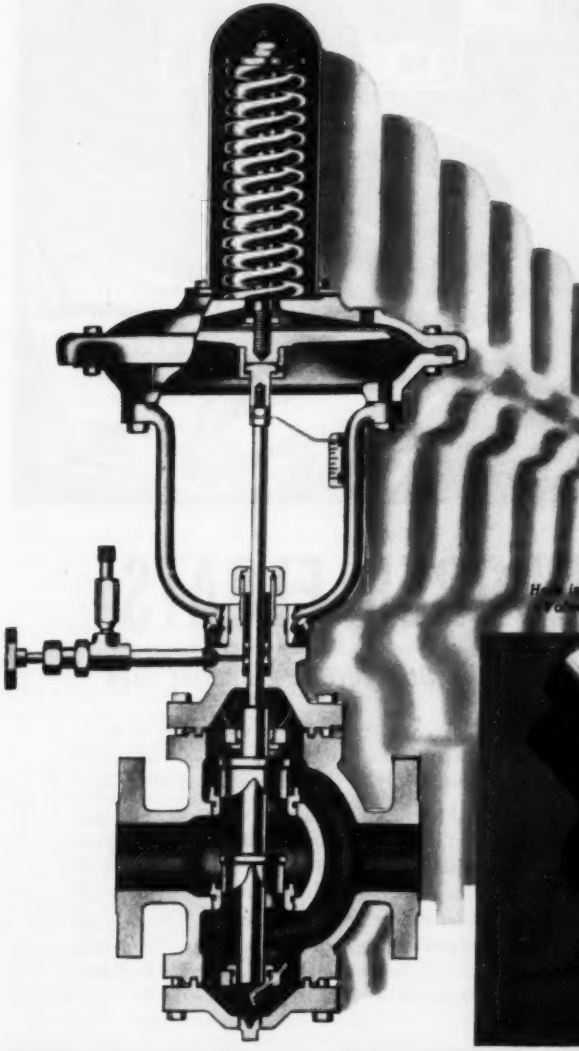
Carrier Centrifugal Compressors are available in standard designs from 2000 to 40,000 cfm, with three to seven wheels. In most cases they need no individual engineering. And they're built from standard, pretested components — you're sure of good performance right from the start.

There's a lot more to our Centrifugal Compressor story, of course. Why not consult the Carrier office nearest you? Or write Carrier Corporation, Syracuse 1, New York, for the catalog, "Centrifugal Compressors for Industry."



Carrier has built more multi-stage Centrifugal Compressors than any other manufacturer. Here is one of them (left) on the job at a petroleum company. Skilled workmanship, precision inspections (right) and grueling tests make Carrier Centrifugal Compressors the most dependable you can buy.

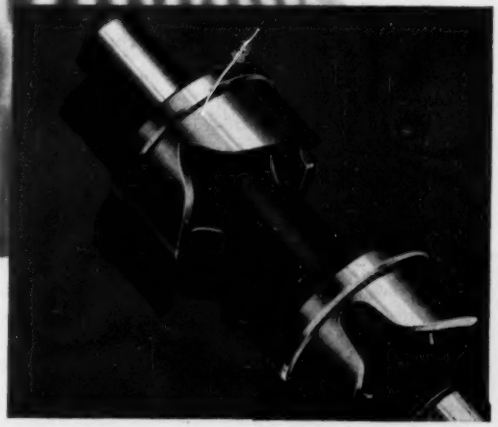
LET 60,000 INSTALLATIONS GUIDE YOU TO BETTER PROPORTIONAL CONTROL



Optimum flow characteristics, coupled with free-floating, self-aligning motor action, have made "Stabilflo" the most preferred name in control valves. Ever since the development of proportional control, critical users have depended upon these wide-range V-port valves for the utmost in performance.

Because of their unique port design, Stabilflo Valves give very precise "equal percentage" flow relations throughout the range from 2 to 100% of flow. Their rangeability is 50-to-1. With these valves, you can be sure that the extraordinary sensitivity, accuracy and dependability of modern proportional controllers are translated into matching valve performance. Get the details in Bulletin 277-2. Write **The Foxboro Company, 1823 Neponset Ave., Foxboro, Mass., U. S. A.**

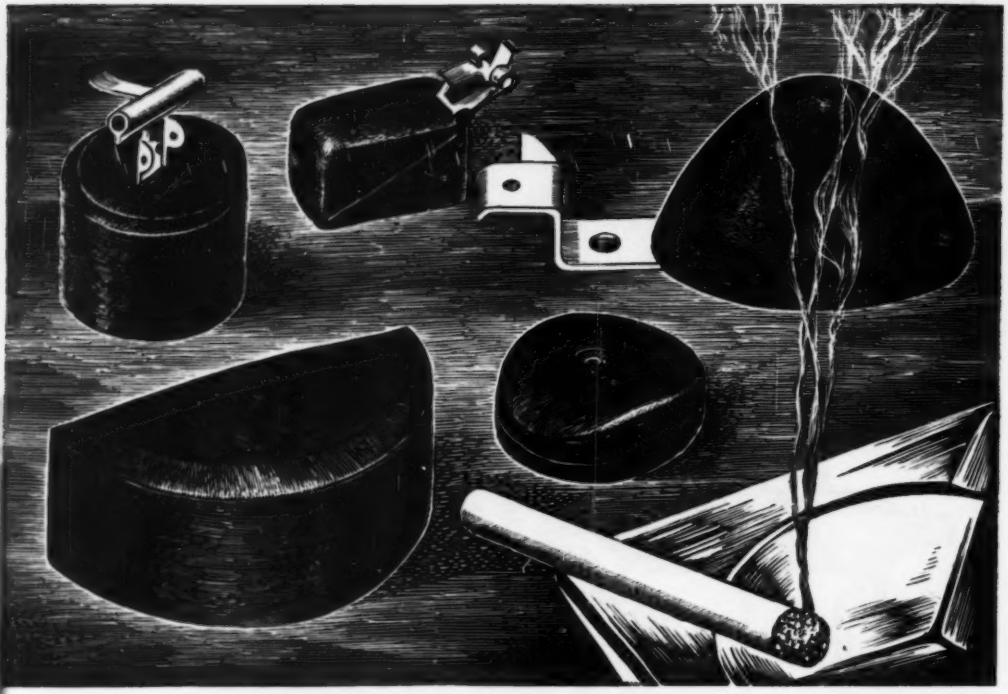
Here is the Foxboro Exponential Port that gives Stabilflo Valves their unique equal percentage characteristic.



FOXBORO
REG. U. S. PAT. OFF.

STABILFLO CONTROL VALVES

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND



CELLULAR RUBBER FLOATS

Spongex CELL-TITE floats can't be punctured... cannot leak

In many ways permanently buoyant *Spongex Cell-Tite* (hard cellular rubber) makes better floats than those of hollow metal design. Stronger than hollow metal floats, *Cell-Tite* floats cannot be dented or pressed out of shape. Unlike metal, *Cell-Tite* is not subject to expansion and contraction, caused by temperature changes.

Floats of *Spongex Cell-Tite* have no raised seams to waste space... their volume completely occupies their greatest dimensions. As the density of *Cell-Tite* can be varied over a wide range, you are permitted changes in flotation properties *without* changing molds, tooling and other costly-to-alter elements of your design.

Floats might be the last thing on your mind. But if cellular rubber (hard or soft) is on your mind, let's talk it over. Our development facilities plus 29 years experience compounding cellular rubber are at your service. There's a lot of preliminary help in our booklet—"Properties of and Technical Data on Cellular Rubber." Write for it—it's free.

SPONGEX®

for cushioning, insulating, shock absorption, sound and vibration damping, gasketing, sealing, weatherstripping and dust proofing.

THE SPONGE RUBBER PRODUCTS COMPANY 501 Derby Place, Shelton, Conn.

How to *INCREASE BOILER RATINGS*

with your present furnace and stack

Coppus-Dennis FANMIX Burners Give You More Heat with No Other Major Change in Equipment

Coppus-Dennis **FANMIX** Burners give you *perfect* mechanical mixing of fuel and air *at the burner outlet . . . instantaneous* ignition close to the burner . . . and *complete* combustion *without visible flame* when burning natural gas. No other burner combines these three advantages.

Because **FANMIX** delivers the *right* mixture of fuel and air *without blow-torch action*, all of your furnace space is used for combustion . . . *none for mixing*. That's why your present furnace can release more heat . . . why new installations can get more heat out of smaller furnace space.

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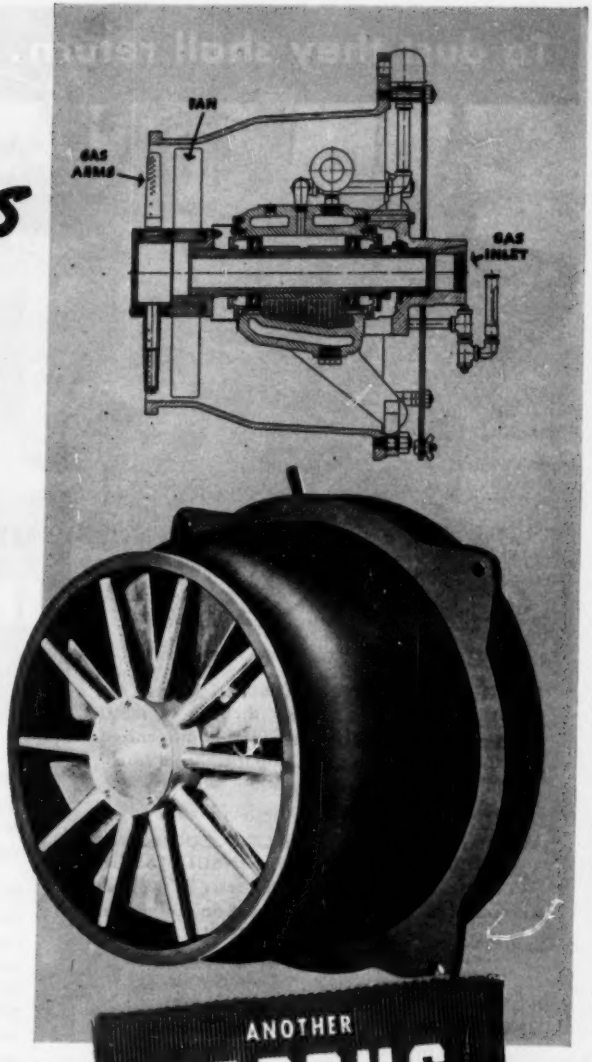

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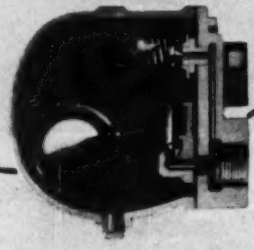

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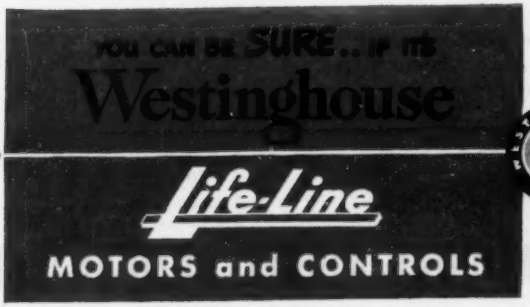

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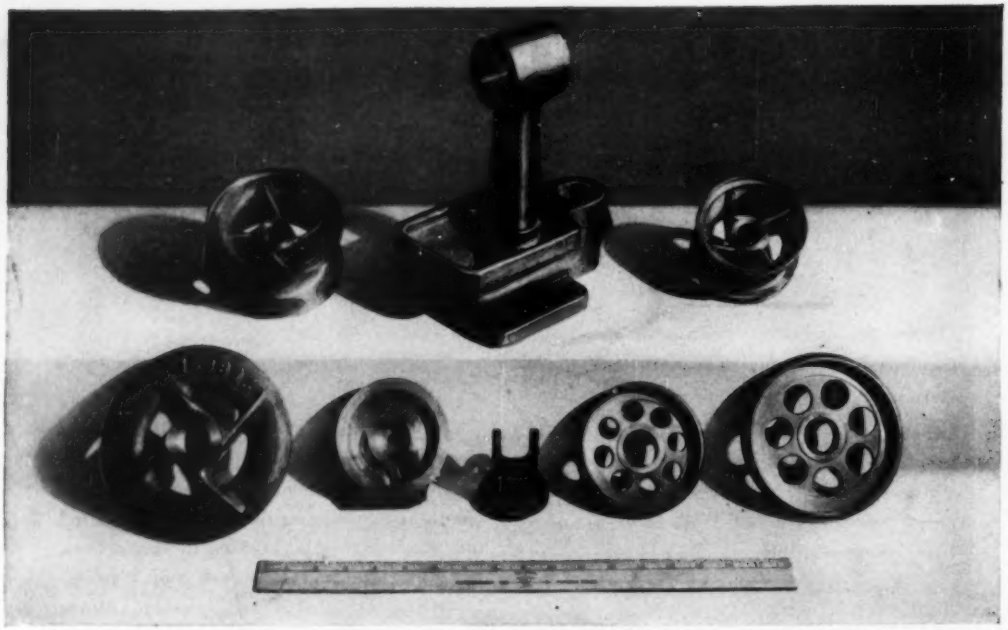

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MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 74 NUMBER 3

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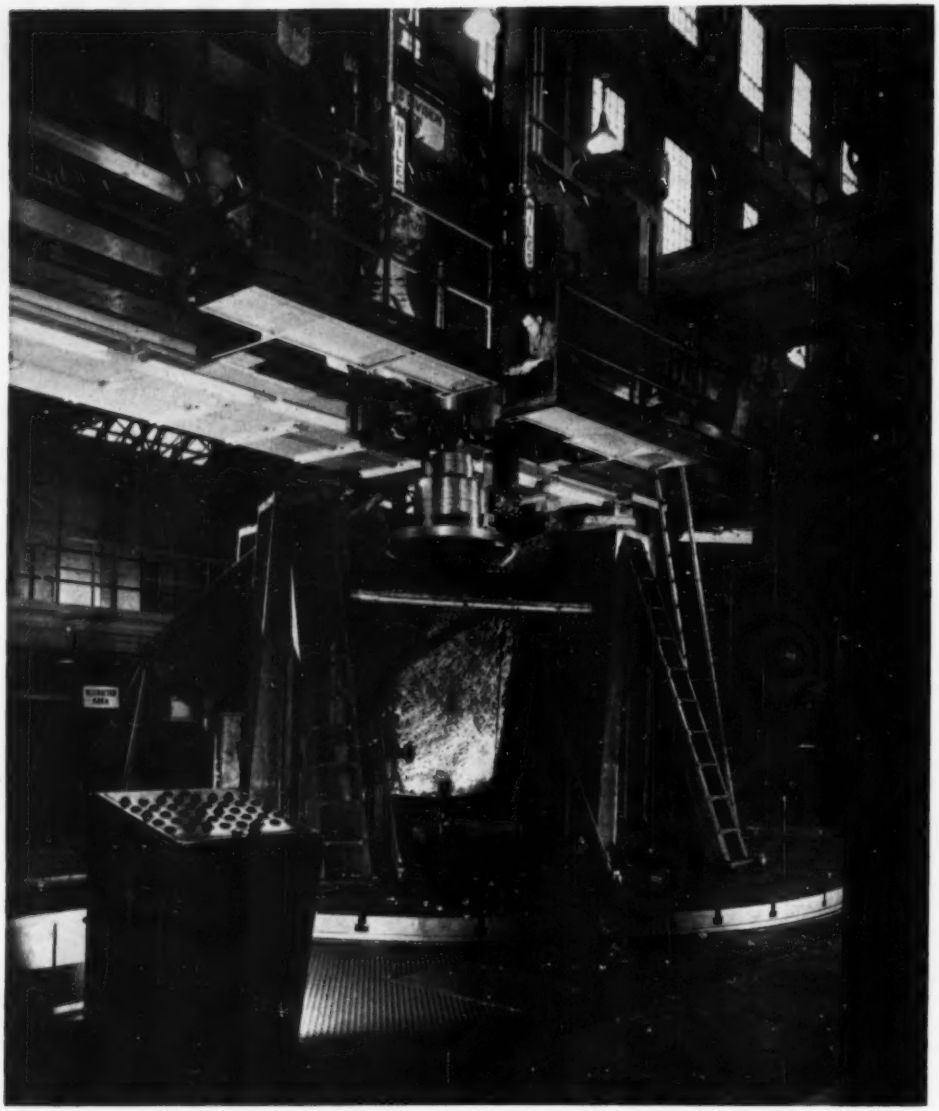

Kaplan-Type Runner Vane Undergoes Vertical Machining on 30-Ft Mill

(An adjustable pitch Kaplan-type runner vane, one of two for 55,000-hp hydraulic turbines under construction at Allis-Chalmers for TVA's Pickwick Landing Plant, is shown being vertically machined on a 30-ft boring mill. The size of this job makes the operation particularly interesting. A lathe for this machining operation would be required to swing 20 ft and carry a weight of 14 tons on the centers, as steadyrests, something which would not be feasible. By placing a center on the table and a tail stock on the boring-mill rail, the operation is performed on this boring mill. The completely assembled adjustable vane runner is nearly 24½ ft in diameter and is the largest of this type in physical size in the U. S. The two turbines will make a total of six such record-size units built and constructed by Allis-Chalmers for the Pickwick Landing Plant.)

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MECHANICAL ENGINEERING

MARCH
1952

GEORGE A. STETSON, *Editor*

Unity Soon?

ENGINEERS and engineering societies in the United States are facing an important decision. Shall they take the next step toward development of a unity organization?

Since Oct. 20, 1949, representatives of fifteen major engineering societies which have been known as the "Exploratory Group to Consider the Increased Unity of the Engineering Profession" have been studying the desirability and practicability of a unity organization of engineers. On Dec. 16, 1950, the Exploratory Group adopted, as a basis for discussion by the societies, a progress report in which four different plans of organization were described. More than three thousand copies of this report were distributed within the fifteen societies. Throughout the nation the report and the four plans of organization were discussed by individuals and groups of engineers within the societies. On Sept. 28, 1951, the results of these discussions were placed before the Exploratory Group. The group decided to prepare a report, including a recommendation to the constituent societies and to Engineers Joint Council "to the effect that a unity organization be organized first by the development of EJC along the general lines of Plan A, and suggesting further steps to be studied by the unity organization after the completion of the first step." On Dec. 15, 1951, the Exploratory Group adopted the report that was prepared and on Jan. 25, 1952, presented it to Engineers Joint Council. EJC, in turn, has referred the report to the societies represented in the Exploratory Group. The full text of the report, and the full text of the minority report submitted by the representative on the Exploratory Group of the National Society of Professional Engineers, will be found in the news section of this number.

The desire for a unity organization of engineers has been expressed by many persons and organizations in many different ways, over a period of many years. This magazine in the past has published a number of articles expressing this desire and describing how a powerful all-inclusive engineering society might be organized. Urgent and constructive as many of these plans of organization were, none ever resulted in a serious attempt to bring engineers together.

It will be remembered that the Exploratory Group came into being as the result of an invitation of Engineers Joint Council to sixteen national engineering societies to name one representative each "to attend a meeting to explore the desirability and practicability of increasing the unity of the engineering profession." Once this Group organized itself, EJC made no attempt to influence the discussions or decisions. It distributed to the societies represented in the Group the report of Dec. 16, 1950, in which four plans of organization were put forward for general discussion.

Wide publicity was given to the following plans.

Plan A, the "EJC Plan," contemplated "the expansion of EJC to include other engineering societies which are eligible under the present constitution of EJC."

Plan B, the "Modified EJC Plan," proposed "expansion of EJC to include other engineering societies and also to provide for a voluntary individual membership."

Plan C, the "Merger Plan," contemplated "the merger of EJC and of NSPE (National Society of Professional Engineers) into a single body and the expansion of the merger organization in the ways necessary to enable it to represent the entire engineering profession."

Plan D, the "NSPE Plan," proposed "adoption of NSPE as the unity organization and expansion of its membership and activities through the co-operation of other engineering societies."

The 1950 report of the Exploratory Group was given thorough study during the spring of 1951 by ASME Sections and regional administrative committees. In voting on the four plans at ASME regional administrative committee meetings, Plans A and B, based on EJC, received 53.4 per cent of the votes. The subject was further discussed at the 1951 ASME Regional Delegates Conference held in connection with the Semi-Annual Meeting at Toronto, Canada, resulting in a motion which was approved by the ASME Council. This motion included the following points: That greater unity is desirable; that it "can best be accomplished by continuing and extending" the activities of EJC; that "unity organizations of the council type should be organized at the local level," that direct channels of communication should be established between the national and local unity organizations and between the latter and the sections of the participating societies; that "all members of the national unity organization should be members of the participating societies;" and that "financial support of the national and local unity organizations should come from the national organizations of the participating societies."

Reference to the report of the Exploratory Group as presented to Engineers Joint Council on Jan. 25, 1952 (printed in full in the news section of this number of MECHANICAL ENGINEERING), will reveal the few simple steps by which the proposed unity organization may be brought into being. The first step is for EJC to "invite

all constituent societies represented in the Exploratory Group to become constituent societies of the Council." Second, it is recommended that EJC modify its constitution "to provide for membership on the Council by representatives of the constituent societies appointed or elected for the purpose and to provide for a number of representatives from each society, ranging from one to three." Third, the Exploratory Group recommends acceptance of the EJC invitation by the societies. Finally, it recommends "that the enlarged Engineers Joint Council give further study to the matters discussed in Sections C (General Objectives), D (Major Questions to be Considered by a Unity Organization), and E (Membership of Individuals in Unity Organization) of this report and take appropriate action on each of these matters."

It will be seen that the effect of these recommendations is first to enlarge EJC, at present made up of the four Founder Societies and the American Institute of Chemical Engineers, and then to place upon the enlarged "unity organization" the responsibility of making such further changes in objectives, functions, and individual membership as may be worked out.

Actions of the Engineers Joint Council on January 25 were "to receive the report of the Exploratory Group and refer it simultaneously to the Executive Committee and to the constituent societies of EJC for study and report back to EJC as soon as practicable," and further "to transmit the report to the organizations represented on the Exploratory Group not constituent in EJC for a statement of probable action of each society if the recommended action is taken and an invitation extended to join a unity organization."

Here, then, is a start toward unity in the engineering profession. This magazine believes the questions involved are important enough to warrant publication in full of the report of the Exploratory Group, including a minority report and the sections of the main report relating to matters which the Group recommends be considered after EJC has enlarged its membership. It is urged that every engineer read the report. He will hear much discussion of it in the coming months. Many will be asked to express opinions and to vote on the question. If engineers will inform themselves of the proposals and come to a decision on what action should be taken, it may be possible that we shall have unity soon.

One Hundred Years

IN September of this year more than fifty engineering societies and related organizations will hold meetings in Chicago where the American Society of Civil Engineers will observe its centenary. An exhibition of engineering achievements and a convocation devoted to the effects that engineering has had on the economic, social, and political life of the nation and the progress that has taken place in essential areas of engineering practice will direct public attention to engineers and engineering. Growing out of this convocation there should result one or more publications, addressed to young people and laymen, and designed to show how engineering had aided in the development and maintenance of the American way of life, and the high standards of material well-being enjoyed by our citizens.

This significant series of events is appropriately to be known as the Centennial of Engineering. By means of the Centennial of Engineering the engineering societies have an opportunity to unite in an impressive display of their achievements and to emphasize their importance in our national life. Would it not be appropriate, as Everett S. Lee has suggested, for the Centennial to serve as the occasion for the formal inauguration of the long-awaited unity organization of the engineering profession?

Heald at N. Y. U.

THE head of the largest university in the United States is an engineer. He is Henry T. Heald, a member of ASME and ASCE, who became chancellor of New York University in February. The University is reputed to have more than 60,000 students enrolled in its 14 schools, colleges, and divisions in six centers of instruction and a faculty of about 4000.

Dr. Heald was graduated in civil engineering from Washington State College in 1923, received a master of science degree in civil engineering from the University of Illinois in 1925, and began his teaching career at Armour Institute of Technology in 1927. He was advanced through deanships to the presidency; and when the Illinois Institute of Technology was formed by consolidation of Armour and Lewis Institute, he became president of the new organization. Under his leadership Illinois Institute of Technology grew in size and importance in the field of engineering education and engineering research and he grew in national stature.

In the Chicago area and in the nation at large, as well as in the field of education, Dr. Heald has given unsparingly of his services and talents. The list of honors that have already come to him, a man still under fifty, is a long one. His activities have included the American Society for Engineering Education, the Western Society of Engineers, and the Association of Urban Universities, all of which he has served as president; the Illinois Engineering Council, the American Council on Education, the National Safety Council, Engineers' Council for Professional Development, American Ordnance Association, American Public Works Association, American Association for the Advancement of Science, the Chicago Association of Commerce and Industry, the Rotary Club of Chicago, Community Fund of Chicago, and many other community and national organizations. He is or has been a director of many well-known companies. He has served his country in several capacities and has received the Navy Award for Distinguished Civilian Service. In 1940 he was named by the National Junior Chamber of Commerce as one of America's ten outstanding young men. Libraries, school boards, research, civic, and religious organizations have enlisted his talents.

In his work at New York University, Dr. Heald undertakes the biggest task of his career. Engineers are proud of his record. Wholeheartedly they wish him success.

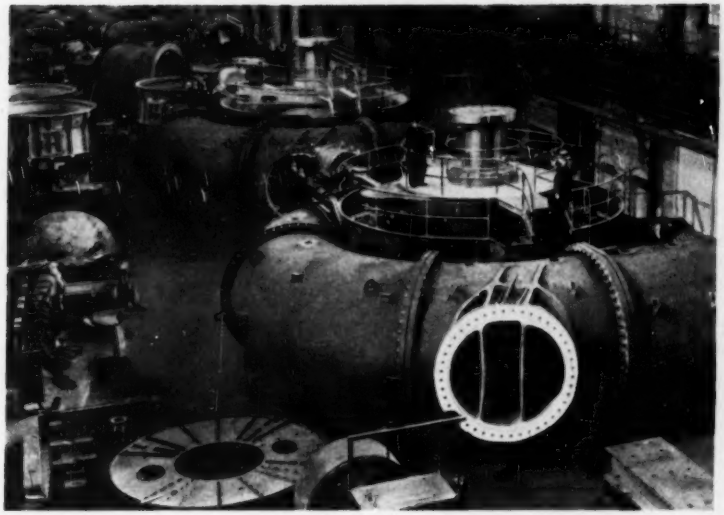

FIG. 1 TWO OF FIRST FOUR 115,000-HP 480-FT-HEAD HYDRAULIC TURBINES WITH CAST-STEEL SPIRAL CASINGS FOR HOOVER POWER PLANT

Recent DEVELOPMENTS *in* FRANCIS TURBINES

By WM. J. RHEINGANS

MANAGER, HYDRAULIC SECTION, POWER DEPARTMENT, ALLIS-CHALMERS MANUFACTURING COMPANY, MILWAUKEE, WIS. MEMBER ASME

ONE of the most important developments in recent years in design and manufacture of Francis turbines is the increased use of welded plate steel. Spiral cases, stay rings, head covers, bottom plates, discharge rings, wicket gates, and even the Francis runners have been and are being made out of welded plate steel. The principal reason for this is that while the art of welding has been improving steadily during the past 10 to 15 years, the cost of patterns and steel castings has kept increasing relatively faster than the cost of steel plate. Thus it has been possible to use fabricated constructions which will withstand the loads and stresses and at the same time be more economical than castings.

WELDED PLATE-STEEL SPIRAL CASINGS

By the use of welded plate steel in the place of castings, savings can be made both in the weight of the turbine and in the cost. For hydraulic turbines the usual maximum design stress for cast steel is 10,000 psi, for both tension and compression, while for plate steel it is 12,000 psi. This alone represents a possible saving of 17 per cent in the amount of steel required. Excellent examples of this are the 115,000-hp hydraulic turbines which have been furnished for the Bureau of Reclamation, Hoover Power Plant. The first twelve turbines installed in this power plant have cast-steel spiral cases. Recently two additional turbines were installed which have spiral cases of welded plate steel. Since seven of the original turbines with cast-steel spiral cases, and the two recent turbines with plate-steel spiral cases were all furnished by one manufacturer, it is possible to make a direct comparison between the two types of construction, both as to weight and as to cost. Such a comparison shows that the finished welded-plate-steel casing weighed 30 per cent less than the cast-steel casing, and cost 20 per cent less to manufacture, including the cost of the material. Since the spiral casings represent approximately 30 per cent of the total weight of the turbine and 25 per cent of the total cost, the saving in total weight of the turbine was 9 per cent, and the saving in total cost was 5 per cent.

In making the comparisons, allowance was made for the fact that the cast-steel casings on the first seven units were slightly larger than the two welded-plate-steel casings. Fig. 1 shows the cast-steel casings for the original units, and Fig. 2 shows the welded plate-steel casings, for the last two units.

There was a further saving of approximately 3 per cent in the total cost owing to the fact that when the original turbines were built, steel foundries accepted skeleton patterns for making

Contributed by the Hydraulic Division and presented at the Annual Meeting, Atlantic City, N. J., November 25–30, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

TABLE 1 PARTIAL LIST OF LARGE TURBINES WITH WELDED PLATE-STEEL CASINGS

Power plant	No. units	Hp	Head, ft	Casing inlet diam, ft-in.	Type of casing sections	Type of field joint	Year installed
Aluminum Co. of Canada, Shipshaw	8	100000	208	16-0	Shop-welded stress-relieved by peening	Field-welded and peened	1942 and 1943
TVA, Fontana	2	91500	330	12-0	Shop-welded furnace stress-relieved	Field-welded and peened	1945
Carolina Aluminum Company, Cheoah Unit No. 5	1	45000	188	12-0	Field-welded and peened	Field-welded and peened	1949
New Zealand, Maraetai	5	50000	195	12-0	Field-welded and peened	Field-welded and peened	Being installed
Bureau of Reclamation, Grand Coulee	9	165000	330	15-0	Shop-welded furnace stress-relieved	Flanged	1947 to 1951
Bureau of Reclamation, Hoover	2	115000	480	10-0	Shop-welded furnace stress-relieved	Flanged	Being installed
Bureau of Reclamation, Hungry Horse	4	105000	400	11-0	Shop-welded furnace stress-relieved	Flanged	Being installed
City of Seattle, Gorge	1	82500	280	12-6	Shop-welded furnace stress-relieved	Flanged	1950
Bureau of Reclamation, Shasta	5	103000	330	12-3	Shop-welded furnace stress-relieved	Riveted	1942 and 1949
U. S. Army Engineers Bull Shoals	4	62000	190	14-8	Shop-welded furnace stress-relieved	Riveted	Being installed
U. S. Army Engineers Fort Randall	8	57500	112	19-9 1/8	Partly shop-welded furnace stress-relieved	Riveted	Being manufactured

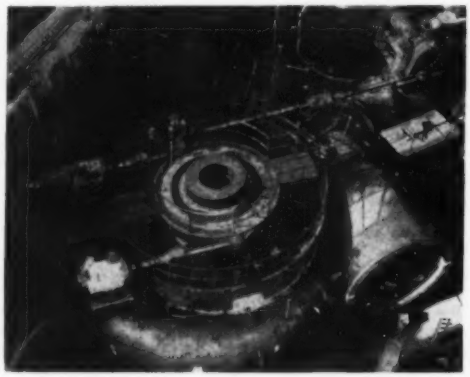

FIG. 2 115,000-HP 480-FT-HEAD HYDRAULIC TURBINE WITH WELDED PLATE-STEEL SPIRAL CASING FOR HOOVER POWER PLANT

cast casings. At present, most steel foundries will insist upon solid patterns which cost two to three times that of skeleton patterns.

As shown in Fig. 2, the welded plate-steel casing sections are constructed with flanges for bolting the sections together in the field. A further saving estimated at 16 per cent in the weight of the casing and 30 per cent in the cost could have been obtained by omitting the flanges and designing the joints between the sections for field welding. This would have meant a saving of approximately 5 per cent in the total weight of the turbine and 7 per cent in the total cost. Therefore turbines using welded plate-steel casings with field-welded joints will weigh about 14 per cent less than turbines with cast-steel casings and flanged joints. This saving in material is especially important at the present time with steel a critically scarce item in our over-all economy.

Accompanying the saving in weight there is a possible saving of about 15 per cent in the total cost of the turbines. However, this saving is in the manufacturing cost, and allowance must be made for the added erection costs due to field-welding the joints between the casing sections. It is estimated that for spiral cases similar to those furnished for the Hoover turbines, the cost of field-welding would amount to approximately 2 per cent of the total cost of the turbine. Therefore the over-all saving would be about 13 per cent.

Another advantage of the welded spiral casing as compared to the cast-steel casing is the reduction in the possibility of defective material quite common in complicated steel castings. Recently some large welded plate-steel casings for high heads, such as the casings for the Gorge Power Plant and Hoover Power Plant (see Table 1), were shipped to the site without making a hydrostatic-pressure test in the manufacturer's shop. This test was made in the field, permitting earlier shipment and resulting in some saving in manufacturing cost.

The manufacturer was justified in taking this risk because of the nearly absolute assurance that the casings would not develop any leaks or flaws when pressure-tested. Later this was confirmed by the actual tests in the field. A similar procedure scarcely would be recommended for cast-steel casings.

The large savings in both weight and cost of the welded plate-steel casings plus other advantages, compared to cast or riveted casings for large turbines for medium and high heads, therefore merit careful consideration. This also applies to the possible use of field-welded joints in place of flanged or riveted joints. During recent years a large number of the penstocks leading up to turbines have been and are being welded in the field, but field-welding of turbine scroll cases has not been permitted in very many installations.

Some notable exceptions to this are the turbines for the TVA, Fontana Project, the turbines for Aluminum Company of Canada, Shipshaw Plant, and the turbine for the Carolina

Aluminum Company, Cheoah Plant, Unit No. 5, all of which have plate-steel casings welded in the field.

The Fontana Project consists of two 91,500-hp turbines operating under gross heads from 245 to 435 ft, with 330 ft being the rated head. The spiral casing, Fig. 3, has a 12-ft-diam inlet with plate thickness varying from $1^1/_8$ to $1^7/_8$ in. The stay ring is of cast steel and made up of five equal sections designed to be bolted rigidly together. The spiral casing is divided into eight sections, five sections corresponding to the five stay-ring sections, plus three inlet sections. Since the highest stress in the casing occurs near the joint between the plate and the stay ring, the sections are so designed that all of those joints could be shop-welded and thus could be furnace stress-relieved. Each section consists of a number of plates with circumferential joints, which were shop-welded. The circumferential joints between sections and some of the longitudinal joints in the inlet sections were welded in the field. All field welding was done under extensometer control. All welds were peened, the amount of peening being controlled by the extensometer readings. Specimens were cut daily from the work of each welder, and tensile tests were made immediately on a portable testing machine. As a further test of the strength of all the welded joints, the casings were tested under 375 psi pressure which is double the maximum static head. The units have been in satisfactory operation since 1945. A third unit with welded plate-steel spiral casing with section joints arranged for similar field-welding has been ordered recently, and is now in the process of manufacture.

The Cheoah Power Plant, Unit No. 5, for the Carolina Aluminum Company is rated 45,000 hp at 188 ft head. The inlet to the spiral casing is 12 ft. This casing was entirely welded in the field, including all of the joints between plates and the joints between the plates and the stay rings. The unit has been in satisfactory operation since 1949.

The Shipshaw Development[1] on the Saguenay River in Canada was the first installation in North America to utilize spiral casings of all-welded construction. The development consists of twelve hydraulic turbines, eight of which are rated 100,000 hp each at 208 ft head, and four are rated 85,000 hp at 208 ft head. The inlet diameter of the scroll casings is 16 ft. All of the plates in the spiral casings in the eight 100,000-hp units were welded to each other and to the cast-steel stay-ring sections. The other four casings used riveted joints.

[1] "The Engineering History of Shipshaw," by McNeely DuBose, *The Engineering Journal*, published by The Engineering Institute of Canada, vol. 27, 1944, pp. 194–199.

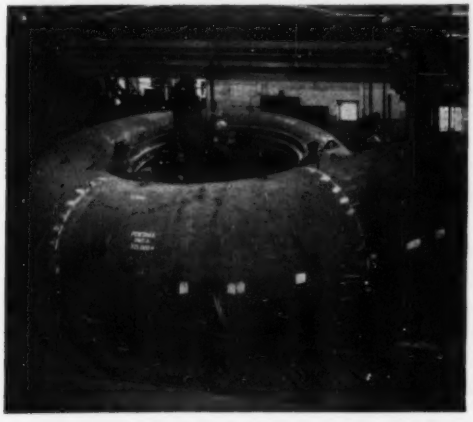

FIG. 3 ALL-WELDED PLATE-STEEL SPIRAL CASING FOR 91,500-HP 330-FT-HEAD TURBINE FOR FONTANA POWER PLANT

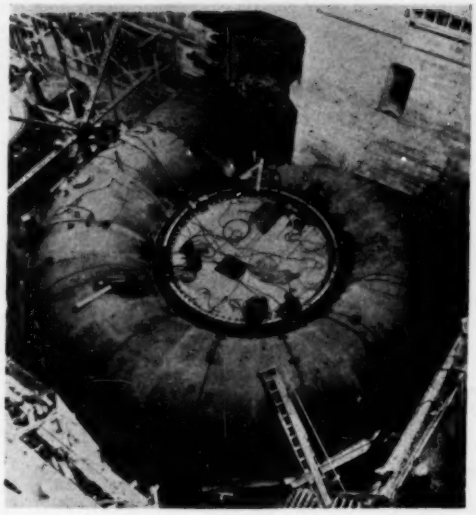

FIG. 4 FIELD ASSEMBLY OF ALL-WELDED PLATE-STEEL SPIRAL CASING FOR SHIPSHAW DEVELOPMENT, CANADA

Fig. 4 shows the assembly of one of the all-welded casings in the field before welding the field joints. No furnace stress relieving was used for either the shop or the field welds. The units were placed in operation during 1942 and 1943, and no trouble has been experienced with any of the welded joints.

Although these installations demonstrated that welding with mechanical stress-relieving is entirely satisfactory, if properly done, some engineers still feel that some form of temperature stress-relieving is advisable. Recently, a controlled low-temperature method of stress-relieving welds in place has been devised, which could be used to stress-relieve field welds. Numerous tests have been and are still being made to determine whether this method is satisfactory. No definite conclusion has been reached as yet, but the results obtained so far are promising. If this method should prove to be as effective as furnace stress-relieving, then the future will see the use of a larger number of spiral casings of all-welded construction.

WELDED INSTEAD OF RIVETED JOINTS

Although welded plate-steel spiral casings are particularly advantageous for large-capacity units of medium and high heads, welded construction also has certain advantages for the extremely large-sized casings for lower heads. Riveted joints in large casings present quite a problem. This is particularly true at the junction between the plates and the stay ring where the maximum stresses occur. To make riveted joints for some of the extremely large casings requires four and five rows of rivets and a double butt-strap design. This can be eliminated by using a welded joint at these points. Fig. 5 shows an assembly of the 14-ft 8-in-diam inlet casing for the four Bull Shoals turbines rated 62,000 hp 190 ft head. Fig. 6 shows the welded juncture between the steel plates and the stay ring. Not only were these joints welded, but as many of the remainder of the

FIG. 5 WELDED AND RIVETED PLATE-STEEL SPIRAL CASING FOR 52,000-HP 190-FT-HEAD HYDRAULIC TURBINE FOR BULL SHOALS POWER PLANT

joints were shop-welded as shipping limitations permitted.

Fig. 7 shows the assembly of one of the 19-ft $9^1/_2$-in-diam inlet spiral cases for the eight hydraulic turbines for the U. S. Army Engineers, Fort Randall Project. These turbines are rated 57,500 hp at 112 ft head. Here again, the critical joint between the casing and stay ring is shop-welded (see Fig. 8). The longitudinal joints for field riveting are located at points where the stresses are lower, thus permitting a simpler type of joint. Owing to shipping limitations it was impossible to make completely welded sections.

By x-raying all of the shop-welded joints and by furnace-stress-relieving the welds, 90 per cent joint efficiency can be used in the design. This permits the use of lighter plate than would be required if a riveted joint were used. The saving in material plus the saving in the work required to prepare a double butt-strap riveted joint just about equals the cost of making an x-rayed, stress-relieved, welded joint. There is, of course, an additional saving during erection of the turbine in the field.

As an example, the shop-welding on the spiral casings for the Bull Shoals turbines eliminated approximately 12,000 rivets per casing $1^1/_4$ in. diam. The cost of driving the remaining 3000 rivets per casing amounts to about $1 per rivet. Therefore the shop-welding represents an approximate saving in field erection of $12,000 per casing. There is an additional saving in field erection in the elimination of the work necessary to assemble the plates preparatory to riveting and calking the joints after the riveting is completed. This saving is estimated at an additional $7000 per casing, making a total saving of $19,000 in field erection. This represents a saving of between 4 and 5 per cent of the total cost of the turbine. Therefore this type of construction should be given careful consideration for large turbines under medium and low heads.

Table 1 lists some of the large hydraulic turbines which have welded plate-steel spiral casings, either with riveted, flanged, or field-welded joints between the sections.

In addition to welded spiral casings, there has been a recent trend toward welded construction of head covers, bottom rings, discharge rings, stay rings, and wicket gates. Since none of these parts present any particular fabricating problems, the details of their construction will not be described in this paper.

WELDED RUNNERS

Francis runners are difficult to cast, and the price per pound of these castings exceeds the price for any other hydraulic-turbine castings. Therefore considerable thought has been given to the use of welded plate-steel runners. Where a section through the runner bucket can be of constant thickness, such as for low-head installations, a fabricated runner presents no particular difficulty, and quite a number have been so built. The buckets are die-formed from plate steel and welded to plate-steel or cast-steel crowns and bands. However, for the higher heads, the runner buckets must be of varying thickness, with a thin inlet and outlet edge and a heavy center section for strength. This type of bucket is difficult to form out of plate steel, and therefore up to the present time fabricated Francis runners have been limited to low-head turbines.

However, it is possible to cast the runner buckets separately to the proper shape and thickness and then weld them to the crown and band. This permits simpler castings at a lower price

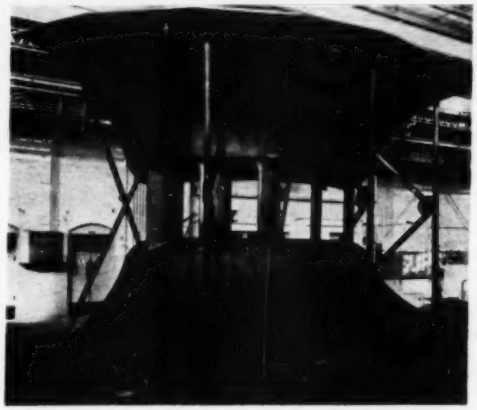

FIG. 6 WELDED PLATE-STEEL SPIRAL CASING SECTION FOR 52,000-HP 190-FT-HEAD HYDRAULIC TURBINE FOR BULL SHOALS POWER PLANT

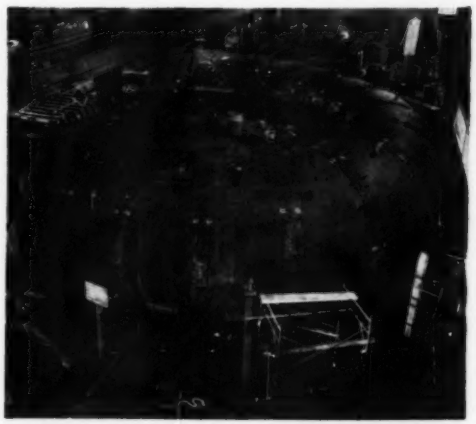

FIG. 7 WELDED AND RIVETED PLATE-STEEL SPIRAL CASING FOR 57,000-HP 112-FT-HEAD HYDRAULIC TURBINE FOR FORT RANDALL POWER PLANT

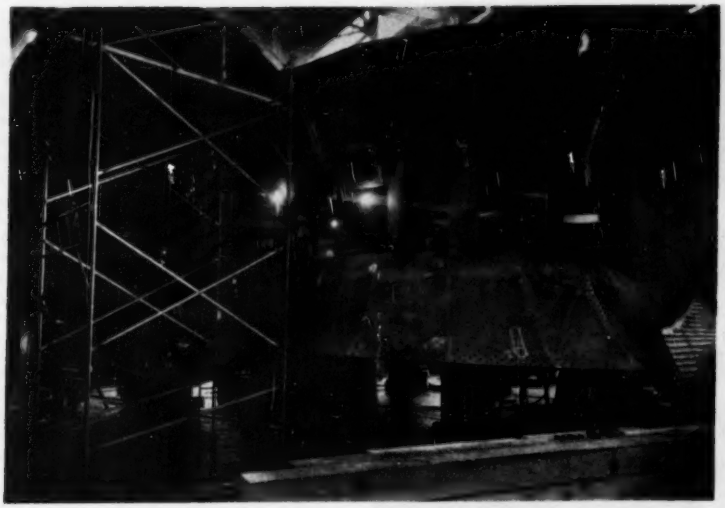

FIG. 8 WELDED PLATE-STEEL CASING SECTION FOR 57,500-HP 112-FT-HEAD HYDRAULIC TURBINE FOR FORT RANDALL POWER PLANT

per pound. It also simplifies the work of grinding the bucket surfaces, and makes it possible to obtain uniform bucket thicknesses and discharge openings. A Francis runner with a 113-in. discharge diameter weighing about 22,000 lb is now being manufactured, using this type of construction. A number of casting, annealing, and welding problems will have to be solved to produce a satisfactory runner of this type but it is believed that if this method of fabrication is successful, it may eliminate some of the difficulties encountered in the past with Francis-runner castings.

USE OF STAINLESS STEEL

In addition to the increased use of fabricated plate steel and welding in hydraulic-turbine construction, there is a trend toward the increased use of stainless steel. Stainless steel has the property not only of resisting corrosive action due to chemicals in the water, but also of resisting the pitting action resulting from cavitation. The use of stainless steel to resist pitting in hydraulic turbines dates as far back as 1928. At first this was mostly in the form of welded stainless-steel overlays on mild cast-steel surfaces to repair pitted areas. After stainless steel proved to be highly resistant to pitting, it was used for pre-welding areas where it was anticipated that pitting would occur.

Since a mild-steel runner with stainless-steel overlays is considerably less costly than a solid stainless-steel runner, and since the use of stainless steel on Francis turbines has been increasing rapidly, attempts have been made to simplify the application of the overlays. A recent development has been the use of stainless-steel strips welded to the surface of mild-steel runner castings. This not only reduces the cost of surfacing with stainless steel, but insures a uniform thickness of the overlay and acts as a guide to the true runner bucket shape during grinding and finishing operations.

Experimental tests also are being made using an inert-gas type of welding, with an uncoated wire where a gas such as argon or helium is used to take the place of the coating on the wire. Preliminary tests indicate that the time of applying overlays of stainless steel can be reduced considerably, that the cost is slightly less, and that the finished surface is much smoother, therefore requiring considerably less grinding. Further tests are being made to determine the amount of dilution and resistance to pitting with this type of weld.

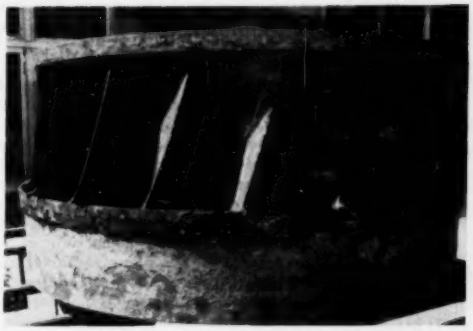

FIG. 9 RUNNER CROWN, BAND, AND PRESSURE SIDE OF BUCKETS OF A CAST-STEEL RUNNER CORRODED BY ACTION OF CHEMICALS IN WATER

There also have been cases where the combination of the corrosive action of the water, plus higher water temperatures, plus some cavitating action produced an extremely rapid rate of wear, not only on the runner but on the wicket gates, wicket-gate stems, the head cover, and the bottom plate. Since there was serious corrosion on all parts of the runner the only solution was a complete 18-8 stainless-steel runner casting. Fig. 9 shows the corroded runner after about one year of operation at full gate. Fig. 10 shows the stainless-steel replacement runner. The stainless-steel runner has now been in operation about $2^1/_2$ years and has shown no signs of either cavitation or corrosion.

FIG. 10 20,000-LB ALL-STAINLESS-STEEL RUNNER FOR 17,000-HP 115-FT-HEAD HYDRAULIC TURBINE FOR POSSUM KINGDOM POWER PLANT

The corrosive action on the wicket gates, wicket-gate stems, head cover, and bottom plate also was eliminated by use of stainless-steel facings and stainless-steel wearing plates.

Solid stainless-steel Francis runners have been furnished for quite a number of high-head installations, and the use of such runners is recommended for heads above 600 to 700 ft. It is also desirable to use stainless-steel wicket gates, facing plates, and wearing rings for high-head installations. Operating and maintenance experience with high-head Francis turbines has indicated that the additional initial cost of using stainless steel for these parts is well repaid in reduced maintenance and outage.

The largest items of maintenance costs on Francis turbines, next to maintenance of the runner, are the wicket-gate stems for both low-head and high-head installations. The wear on these parts is due largely to corrosive action of the water. The use of stainless-steel sleeves for the stems tends to reduce such wear to a minimum and, therefore, such sleeves have been installed recently in a number of turbines.

Wear along the discharge ends of the wicket gates and along the seal point also presents a problem in medium-head and high-head installations. The insertion of stainless-steel strips at these points tends to reduce this wear considerably. Undercutting of the wicket gates where they form a seal with the head cover and bottom plate is also a common occurrence in the higher-head installations. This is overcome by using stainless-steels plates or welded overlays on the ends of the gates. The use of stainless steel for these parts is justified in large turbines where outage for repairs is costly and where an operating life of 20 to 30 years is now expected without a major overhaul of the turbine.

Inlaid rubber strips also have been used on the gate seals and in the head covers and bottom plates to reduce leakage and thus reduce wire drawing and undercutting. These rubber strips have given satisfactory service on a number of turbines.

USE OF AMPCO BRONZE

Another source of damage to hydraulic turbines which frequently combines with cavitation and corrosion is erosion caused by foreign matter such as sand, silt, or glacial deposits in the water. When water at high velocity carries such hard materials in suspension, the damage can be rapid and severe.

Unfortunately, both research tests and actual field operation have indicated that the 18-8 stainless steels, which have a high resistance to pitting, do not have a very high resistance to erosion. In this respect, the chrome stainless steels, with 12 to 14 per cent chrome content, show up much better than 18-8 chrome-nickel stainless. Other promising metals for resistance to erosion are the aluminum bronzes, particularly those that are produced under the trade name of Ampco bronze. A field test is now being conducted which will give a direct comparison between the resistance to both erosion and pitting of manganese-bronze runners, 18-8 stainless-steel runners, and Ampco bronze runners. These runners are installed in units which are subject to large quantities of highly abrasive sand in the water. The original manganese-bronze runners lasted only a short time, and after several extensive repairs, had to be replaced about once every 5 years. About 3 years ago, 18-8 stainless-steel runners were installed to replace two of the manganese-bronze runners. These runners have stood up better than the manganese-bronze runners in that they have shown no signs of pitting. They do show evidence of sand erosion, although considerably less than was obtained on the manganese-bronze runners during a similar period of time. Ampco-bronze runners were installed about 2 years ago to replace the last two manganese-bronze runners. These runners have stood up remarkably well during their 2 years of operation, showing no signs of either cavitation or erosion.

Accelerated cavitation tests on Ampco bronze, whether rolled, cast, or welded, have shown that it is highly resistant to pitting. However, its one big disadvantage is that at present it cannot be welded overhead. If an Ampco-bronze runner requires welding repairs it must be removed from the turbine, since pitting usually occurs on the bottom side of the runner. This increases both the cost and the outage time. However, the high resistance of this metal to both pitting and erosion warrants its consideration for possible use in the manufacture of hydraulic equipment.

It is interesting to note that the high resistance of Ampco bronze to the pitting action of cavitation was discovered during research tests[2] on various metals with an accelerated cavitation machine of the vibratory type. The use of this machine for research tests on various metals has proved to be very valuable, and its continued use promises to develop additional information on the resistance to pitting of a large variety of metals under varying conditions.

SELF-LUBRICATING BEARINGS

Although the major advances in Francis-turbine design have been in connection with the materials of construction, several other features of design deserve mention.

One of these is the self-lubricating bearing, Fig. 11, for vertical units. The bearing runs in an oil bath covering about one third of its length. The babbitt in the bearing has spiral grooves so that the rotation of the shaft produces a pumping action. Thus oil is forced from the oil reservoir to the top where it floods the entire upper portion of the bearing. The grooves also are shaped so that they will lubricate that portion of the bearing not submerged in oil.

The main feature of this bearing which makes its use possible is a leakproof oil reservoir. This requires that the shaft be

[2] "Accelerated-Cavitation Research," by W. J. Rheingans, Trans. ASME, vol. 72, 1950, pp. 705-724.

hollowed out longitudinally as shown in Fig. 11, to permit installation of an oil reservoir which does not have to depend upon a stuffing box or packing box around the shaft to hold the oil.

With this type of construction the actual diameter of the bearing is considerably larger than the rest of the shaft, and therefore is not well suited or economical for shafts above about 20 in. diam. However, the simplicity of the lubrication, the elimination of all mechanical means for circulating oil, and its

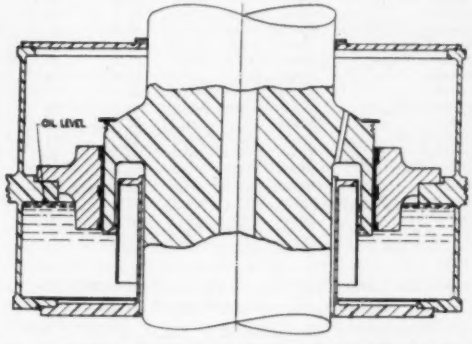

FIG. 11 GENERAL CONSTRUCTION DETAILS OF SELF-LUBRICATING-TYPE BEARING USED ON HYDRAULIC TURBINES

reliability of operation recommends its use for smaller-sized units.

Self-lubricating bearings of this type have now been in successful operation on 15 hydraulic turbines for periods of 3 to 8 years, and so far have given entirely satisfactory operation. However, as is true for all new designs, there are certain features which have to be watched. One is the possibility of loss of oil, by flow along the shaft. Experience has shown that if careful attention is not given to all the details of design, loss of oil can become a serious problem.

CARBON SEAL RINGS

The type of stuffing box, or packing box commonly used in the past, where the shaft passes through the top cover, has not been entirely satisfactory. The packing requires constant adjustment because if it is too tight it heats up and scores the shaft, and if it is too loose the leakage becomes too great. It also produces sufficient wear on the shaft so that renewable

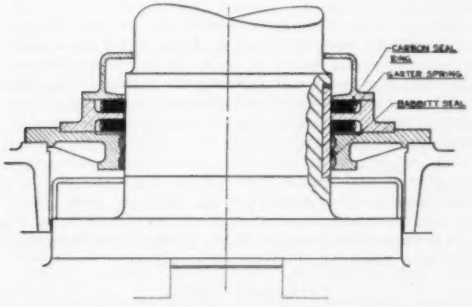

FIG. 12 GENERAL CONSTRUCTION DETAILS OF CARBON-RING WATER SEAL USED ON HYDRAULIC TURBINES

sleeves usually of stainless steel are installed at this point.

Fig. 12 shows a carbon seal ring which can replace the stuffing box. This seal consists of two split carbon rings held against the shaft by means of garter springs. The two rings are separated by a spacer. Water and grease lubrication are provided, although the rings can operate for long periods of time without any lubricant.

The advantages of the carbon seal ring are that it requires no adjustment or attention, seldom requires renewal, and produces very little wear on the shaft. Therefore it can be used in places which ordinarily would be inaccessible or which would require a special design and construction to make the packing ring easily accessible for adjustment.

Carbon seal rings of this type have now been in successful operation on a number of hydraulic turbines for periods of 3 to 5 years. Experience has shown, however, that they are not suited for installations where the water contains a large amount of sand or silt. The carbon rings then have a tendency to wear quite rapidly. Such wear can be reduced greatly or even entirely eliminated by furnishing a clear-water supply to the seal, at pressure greater than the back pressure from the turbine-runner end of the shaft.

INCREASED CASING-INLET VELOCITY

The hydraulic design of turbines also has been subject to considerable change in recent years. One of these is the tendency toward increased spiral-casing velocities. In the past, casing velocities have been limited to about 17 to 18 per cent of the total velocity available. Model tests have indicated very little loss in efficiency when these velocities are increased to about 23 per cent of the total velocity available. Therefore there has been a gradual increase in casing velocity in some of the recent installations with a resulting decrease in size, weight, and cost of the casing.

Table 2 lists the casing-inlet velocities for a number of typical

TABLE 2 SPIRAL CASE INLET VELOCITIES ON SOME RECENT TURBINE INSTALLATIONS

Power plant	Hp	Hp	Actual velocity, fps	Per cent of available velocity
Estes	21000	482	22.2	12.6
Nantahala	60000	925	31.8	13.1
Santa Barbara	36000	808	35.6	15.6
Fontana	91500	330	24.6	16.9
Hungry Horse	105000	400	27.8	17.3
Hoover	115000	480	30.5	17.4
Bull Shoals	61000	190	19.4	17.5
Gorge	82500	280	24.0	17.9
Kortes	18500	200	21.0	18.5
Cheoah No. 5	45000	188	21.2	19.3
Grand Coulee	165000	330	29.0	20.0
Fort Randall	57500	112	17.8	21.0

installations. For high-head installations, the maximum velocity is not only based upon the velocity available but also is limited by the maximum actual velocity considered satisfactory. There has been a tendency in recent years to increase the top limit of the actual velocity from about 30 fps to about 35 fps.

HIGHER SPECIFIC SPEEDS

Another important trend in the design of Francis turbines is a tendency toward higher specific speeds for given heads. Fig. 3, curves 1 and 2 show the upper limitation of specific speed as recommended between 1915 and 1930, as compared to the upper limit recommended between 1930 and 1950. Curve 3 shows the upper limit of specific speed as recommended by American manufacturers since about 1950. These three curves show the gradual tendency toward higher specific speeds. European practice seems to go even beyond these limits. Curve

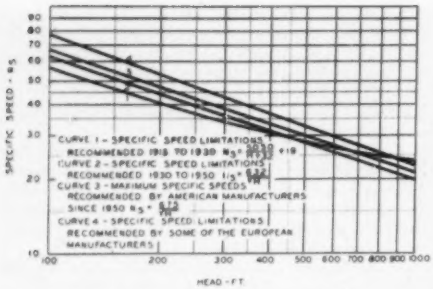
SPECIFIC SPEED - NS
HEAD - FT
CURVE 1 - SPECIFIC SPEED LIMITATIONS RECOMMENDED 1915 TO 1930
CURVE 2 - SPECIFIC SPEED LIMITATIONS RECOMMENDED 1930 TO 1950
CURVE 3 - MAXIMUM SPECIFIC SPEEDS RECOMMENDED BY AMERICAN MANUFACTURERS SINCE 1950
CURVE 4 - SPECIFIC SPEED LIMITATIONS RECOMMENDED BY SOME OF THE EUROPEAN MANUFACTURERS

FIG. 13 SPECIFIC SPEED-LIMITATION CURVES FOR FRANCIS RUNNER

4 shows the upper limit of specific speed as now used by some of the European manufacturers. They are actually manufacturing Francis turbines that go beyond this limit as is shown by the units that are now being built for the Delcommune Power plant in the Belgian Congo, rated 34,000 hp at 244 ft head, 333 rpm, or a rated specific speed of 63.6. The specific speed for this head is considerably above any of the limit curves shown in Fig. 13.

The use of high specific speeds reduces the over-all size, weight, and cost of the unit, but requires a lower setting to reduce cavitation. Also, with the higher velocities encountered, consideration must be given to greater use of stainless steel or similar materials to prevent pitting and wear. This is probably the reason why European manufacturers are using larger amounts of stainless steel in their turbines than American manufacturers.

HIGH-HEAD INSTALLATIONS

Francis turbines are now also being used for high-head installations, in some cases as high as 1300 ft, where in the past only impulse wheels were considered practical. Table 3 shows

TABLE 3 SOME HIGH-HEAD FRANCIS TURBINE INSTALLATIONS

Power plant and location	Hp	Head, ft	Rpm	NS
Vinstra, Norway	69000	1360	500	15.9
Hol, Norway	60000	1265	500	16.3
Zapello, Italy	7500	1200	1500	18.3
Skjerka, Norway	23000	1066	600	14.9
Piottino, Switzerland	28800	1060		
Ixtapantango, Mexico	39000	1028	600	20.4
Waldeck, Germany	40000	1000		
Nantahala, N. Carolina	60000	925	450	21.6
Maudal, Norway	12500	885	750	17.4
Oak Grove, Oregon	35000	850	514	20.9
Santa Barbara, Mexico	36000	808	500	22.0

some of the high-head turbine installations, both in this country and in foreign countries. Here again it is important that special materials such as stainless steels be used for the extremely high-head installations.

TURBINE EFFICIENCIES

Efficiencies based on field tests of Francis turbines in some cases have been about as high as could be expected, and have covered the full range of specific speed. Table 4 shows some of these installations where efficiencies well above 92 per cent were obtained in accurately conducted field tests. No doubt there are other installations with efficiencies equally as high or maybe higher which have not been released for general publication. With efficiencies running between 93 and 94 per

TABLE 4 SOME HIGH-EFFICIENCY INSTALLATIONS

Power plant	Rated hp	Rated head	Rpm	Specific speed	Maximum efficiency, field test, per cent
Osage	33500	90.0	112.5	74.1	92.4
Bellows Falls	20000	60.0	85.7	72.5	93.0
Conowingo	54000	89.0	81.8	69.6	92.4
Holtwood	16500	65.0	94.7	66.0	92.8
Wilson (Units 5 to 8).	35000	92.0	100.0	65.8	93.1
Possum Kingdom					
Brazos River	17000	115.0	171.4	59.4	92.5
Shipshaw	100000	208.0	128.5	51.2	94.7
Norris	66000	165.0	112.5	48.8	93.3
Platte Valley	18000	101.5	257.0	45.1	93.3
Maclaren Masson	34000	185.0	167.0	45.0	92.4
Melones	17700	210.0	227.0	43.6	94.0
Abitibi	66000	237.0	150.0	41.5	93.6
Queenston No. 7	58000	294.0	187.5	37.2	93.8
Diablo	83000	310.0	171.5	37.4	93.0
Pit River No. 3	33000	280.0	225.0	35.7	93.0
Cushman No. 1	24000	230.0	200.0	34.8	92.4
Niagara Falls	70000	213.5	107.0	34.6	93.8
Shasta	103000	330.0	138.5	31.6	93.2
Hoover (Unit N-5)	115000	480.0	180.0	27.1	92.5
Nantahala	60000	925.0	450.0	21.6	93.7
Oak Grove	35000	849.0	514.0	21.0	92.0
Big Creek No. 3	35000	740.0	428.0	20.8	92.9

cent, there seems to be little hope for improvement in this direction. However, the efficiencies listed are for only a few installations, and there are a great number of different Francis-runner designs required to cover the entire range of specific speed. Some field tests have shown disappointingly low efficiencies which indicate a need for continuous model tests and alertness on the part of the manufacturers to attain the high standards not only for a few installations but for the entire range of specific speed and for all installations.

Draft-tube designs still require considerable attention, although there have been no radical changes in the general design features in recent years. The relationship between vertical and horizontal length of the draft tube (for vertical turbines) as it affects turbine efficiency is well known, and these dimensions must be correlated with the cost of installation.

Recent trends in turbine design also have been toward large physical dimensions. The present limit seems to be the largest-size one-piece runner which can be shipped by rail. In this respect ingenious methods have been devised to handle the maximum possible size, such as supporting the runner in special well cars, or between two cars, with the largest diameter of the runner riding only a few inches above the rails. The largest-size runner which can be shipped of course depends upon the limiting railroad clearances, between the foundry and the manufacturer, and between the manufacturer and the power-house site.

The runner size does not necessarily have to limit the size of the unit, because runners can be manufactured and shipped in sections, as has been done for a number of installations. However, it is questionable whether the extremely large-size turbines are economical. A careful review of the cost of various-size turbines indicates that the cost per horsepower increases with the extremely large sizes. Whether this can be offset by savings in generators, power-plant construction, transformers, and other auxiliaries can be determined only by a careful investigation of each project. However, it should not be blindly assumed that the larger the turbine, the lower the cost per horsepower, because recent investigations along these lines have shown that this is not always the case.

REVERSIBLE TURBINES

One of the most recent and interesting developments in Fran-

(Continued on page 211)

DESIGN FEATURES *of a* 250-KW GAS-TURBINE ENGINE

Used as Drive for Shipboard Emergency Generator

By R. R. PETERSON[1] AND P. G. CARLSON[2]

CHARACTERISTICS

IN ITS present state of development, the simple-cycle, nonregenerative, gas-turbine engine is ideally suited to applications where weight and space must be kept to a minimum and where the utilization factor is low, making fuel consumption a secondary factor. An application having these general requirements is found in the gas-turbine engine as a prime mover for a shipboard emergency generator set. In addition to the generally recognized advantages of reduced size and weight, a gas-turbine-engine generator set for naval use offers certain other potential advantages over conventional reciprocating-engine sets which are as follows:

(*a*) A smaller number of parts simplifies the maintenance and spare-parts problem.

(*b*) The set can operate without cooling water.

(*c*) The high-frequency noise can be attenuated significantly by a simple means.

By 1947 the practicability of the gas turbine had been established, largely in the field of aircraft propulsion, and the conclusion was reached by the Department of the Navy, Bureau of Ships, that the advantages offered by the gas-turbine-engine emergency generator as outlined warranted development of such a unit. Accordingly, specifications for competitive bids were issued with the requirements as given in Table 1.

In order to utilize new developments and configurations to the greatest extent, no restrictions on design features or methods of construction were imposed. The present gas-turbine engine for an emergency generator set was planned for installation in a ship being constructed by the Bath Iron Works Corporation with Gibbs and Cox, Inc., New York, N. Y., acting as design agent. In June, 1947, a Gibbs and Cox purchase order for this engine (designated the T-400) was awarded to Solar Aircraft Company, San Diego, Calif.

The basic gas-turbine engine was completed and initially run in September, 1949. Following a development program during which certain design changes were incorporated and accessories and controls were completed and tested, the power plant was delivered in June, 1950, for further testing at the U. S. Naval Engineering Experiment Station, Annapolis, Md. Operational testing at the Experiment Station was begun in August, 1950, and concluded in February, 1951, at which time the gas-turbine engine was delivered to the shipyard for installation.

The air-flow diagram, Fig. 1, shows the sequence of components in the gas-turbine cycle, together with the pressures and temperatures existing when the generator set is providing rated continuous output with ambient-air conditions of 80 F and 14.7 psi pressure. The air-flow rate is approximately 6.6 lb per sec. Fig. 2 shows fuel consumption and turbine-inlet temperature at various loads and ambient temperatures. The specific fuel con-

TABLE 1 REQUIREMENTS FOR GAS-TURBINE-ENGINE EMERGENCY GENERATOR SET

Electrical output, kw	250
Air-inlet temperature, deg F:	
Normal	80
Maximum	100
Exhaust back pressure, in. H_2O max	37
Fuel	Standard Diesel oil
Starting medium	Compressed air or cartridge
Starting time, standstill to full load, sec max	10
Control	Automatic starting and operation, starting signal provided by loss of voltage from main ship's service generators. Means also to be provided for manual operation
Speed governing:	
Steady state, per cent	±0.5
Transient, per cent	±4.0
Recovery time, sec max	0.025
Life	5000 hr of which 500 hr shall be at full load
Sound level	100 decibels (0.0002 dynes per sq cm)
Maximum inclination:	
Permanent	5 deg from horizontal, fore and aft, and 15 deg from horizontal, to either side
Rolling	45 deg from vertical, to either side
Pitching	10 deg from horizontal plane

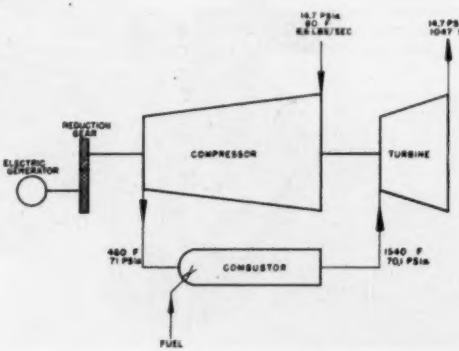

FIG. 1 AIR-FLOW DIAGRAM

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Contributed by the Gas Turbine Power and Power Divisions and presented at the Annual Meeting, Atlantic City, N. J., November 25–30, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

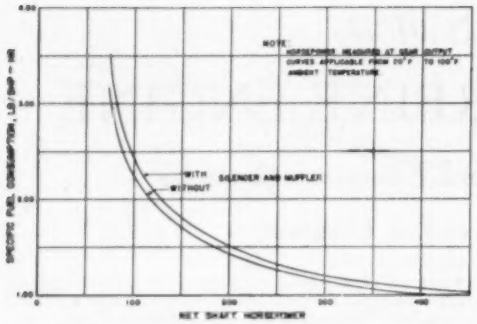

FIG. 2 PERFORMANCE OF T-400 GAS-TURBINE ENGINE

sumption is seen to be approximately 1.07 lb per hphr based on shaft power to the generator.

The design pressure ratio of 4.8 and maximum gas temperature of 1540 F were selected to provide a reasonable compromise between cycle efficiency, life of turbine components, and power-plant size. Considerations of adiabatic efficiency at the pressure ratio chosen, compactness of arrangement, and minimum development time dictated the use of a 10-stage, approximately 50 per cent reaction, axial-type compressor. The comparatively small size of the compressor (9.5 in. average rotor diameter) with associated scale or size effects arising from relatively larger blade-tip and seal clearances and reduced Reynolds numbers, results in a compressor efficiency somewhat less than that obtained on larger axial-flow compressors for which data are available. The peak adiabatic efficiency of 85 per cent and design point efficiency of 80 per cent are, for the pressure ratio selected, still substantially better than could be obtained with other types of compressors on which scale effects may be less. At rated speed of 20,138 rpm, compressor blade-tip velocity is slightly over 900 fps.

Three or four turbine stages would be required to obtain optimum turbine efficiency with the pressure ratio selected. However, in the interests of simplifying the unit and keeping size and weight to a minimum, two stages were chosen, resulting in somewhat poorer turbine performance than otherwise could be obtained. The turbine blading is designed on the vortex principle, utilizing 20 per cent and 11 per cent reaction at the hubs and 49 and 48 per cent at the tips of the first and second stages, respectively. Tip speed of the turbine under rated conditions is 1054 fps.

Pressure drops through the inlet silencer and the exhaust muffler of approximately 4 and 8 in. of water, respectively, impose a penalty of some 20 hp on the engine output. Sound level at a point 6 ft from the power plant and directly in line with the compressor inlet was found to average 97 decibels, a reduction of 10 to 12 decibels from the value obtained without the silencer. Use of the exhaust muffler did not influence appreciably the sound level immediately adjacent to the power plant; however, at exhaust-stack discharge the sound level was reduced from approximately 100 to 95 decibels.

Compressor surge was found to limit the amount of fuel that could be injected during the starting cycle. For this reason the starting-time objective of 10 sec maximum was not attained. The starting time obtainable at present, from starting signal to full speed, is approximately 17 sec. This probably could be reduced by bleeding off compressor air, or by installing a by-pass around the turbine first stage. The complications that would arise from such changes, however, do not appear to be warranted. It should be noted that starting time is a function of the mass and configuration of the driven equipment as well as the energy available for turbine starting.

ARRANGEMENT OF COMPONENTS

The mechanical arrangement of the various components is illustrated in Fig. 3, a cutaway drawing of the unit, and Fig. 4 the assembled unit. It will be noted that the shafts of the principal components (reduction gear, compressor, and turbine) are connected by splined couplings. Inlet air is inducted through a combination silencer-and-oil-cooler assembly lo-

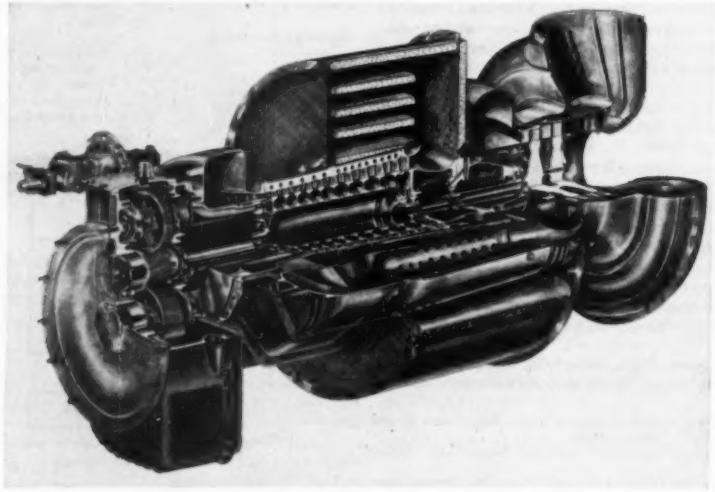

FIG. 3 CUTAWAY VIEW OF T-400 GAS-TURBINE ENGINE INCLUDING INLET SILENCER

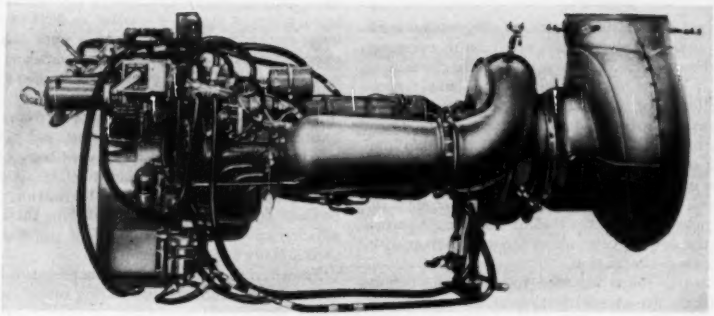

FIG. 4 T-400 GAS-TURBINE ENGINE

cated near the center of the engine, then flows forward through the compressor, is diffused, reversed 180 deg in direction, and passes into a single combustion chamber paralleling the compressor. The hot gas produced in the combustor enters a turbine scroll which conducts and distributes it to the first-stage turbine nozzle. At the exit of the turbine the gas is diffused, after which it enters an exhaust collector which discharges vertically upward. An exhaust muffler is located in the exhaust stack.

It was recognized that a significant pressure loss would be associated with reversing the compressor discharge and locating the combustor parallel with the compressor. However, this arrangement shortens the power plant more than 15 per cent, and, therefore, is considered worth while since length is the critical dimension in this application.

Accessories mounted on and driven from the gearbox include the governor, lubricating-oil pump, fuel pump, speed-sequencing-switch assembly, and tachometer generator.

Considerations of the stresses imposed by shock loads indicated that the loads could be absorbed without the use of shock mounts and without significant weight penalty, providing the generator chosen for the installation could also meet this condition. Consequently, the power-plant mounts, consisting of a trunnion on each side of the generator and a third support, flexible in the fore and aft direction, under the turbine, do not incorporate isolating media.

The weights of the principal components are as follows:

	Pounds
Gas-turbine engine, including ignition system, filters, and piping	350
Control box and instrument panel	56
Reduction and accessory drive gearbox	130
Driven accessories (fuel and lube pumps, governor, etc.)	25
	561
Inlet silencer and exhaust muffler 260	
Total with silencer and muffler	821

Outline dimensions are length 59 3/4 in., width 33 in., height 34 in.

COMPRESSOR

Fig. 5 shows the compressor rotor. A constant 8-in. rotor-hub diameter (rather than maintaining constant blade-tip diameter) is employed to simplify manufacture, particularly in machining the blade attachment slots, although an additional stage is thereby made necessary to obtain the design pressure ratio. This arrangement results in somewhat greater blade heights in the high-pressure stages, which is advantageous performancewise in a small compressor.

The rotor blades, made of type 403 stainless steel, and stator vanes, made of type 347 stainless steel, are produced by cutting four designs of investment castings to suitable length. The rotor blades are attached by means of dovetail joints. The stator vanes are brazed to inner and outer rings, and the assemblies are bolted to the cast-aluminum compressor casing which is made in two 180-deg segments.

The compressor disks are machined from type 403 stainless steel and secured to a drum of $5^{5}/_{16}$ in. diam with rivets which extend radially through the overlapping flanges of the disks and through the drum.

The compressor end thrust of almost 600 lb is absorbed by a single ball bearing located at the inlet end. The discharge end of the rotor is supported on a roller bearing, which allows for differential thermal expansion between the rotor and stator. The compressor scroll casing carries outlet air heated to about 450 F by compression. To cool the area in which the roller bearing is mounted, a small fan integral with the 10th-stage disk circulates air through passages in the casing.

COMBUSTOR

The combustor is of the conventional, through-flow, can-type design with perforated liner such as is used extensively in aircraft turbojets. Specific-heat release at full load is approximately 5×10^{6} Btu per hr per cu ft per atm.

Use of a single combustion chamber eliminates the possibility of starting with an unignited burner. The single chamber is easily removed and inspected without disassembly of the power plant. With injection of fuel through only one nozzle, the nozzle orifice can be kept large, and hence is less apt to clog from impurities in the fuel.

In order to achieve good fuel atomization throughout the speed range and thus assure consistent firing, a variable-area fuel nozzle is employed. A conventional gas-turbine spark plug, energized by a storage battery and vibrator coil during the starting cycle, provides ignition.

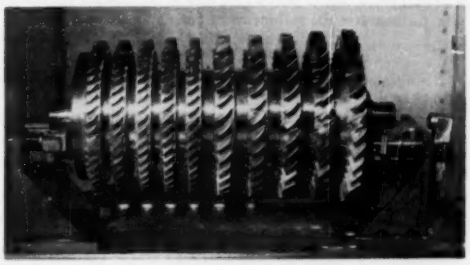

FIG. 5 COMPRESSOR ROTOR

TURBINE

The maximum gas temperature chosen, in conjunction with the conservative design stresses, does not require extensive cooling of the turbine parts. The alloys selected for the critical parts, S-816 and N-155 for the rotor blades and disks, respectively, and Hastelloy C for the nozzle vanes, provide creep and rupture life expectancies of such duration that only moderate cooling of the turbine disk face is required. A small fan integral with the first-stage disk circulates cooling air over the hub and upstream face of the disk. This air then passes around the turbine-inlet scroll, through its shrouding, and around the turbine casing, discharging into the turbine exhaust. A second fan, mounted on the downstream side of the second-stage disk, circulates cooling air in that region.

Conventional fir-tree joints are used to attach the turbine blades to the disks. An unusual feature of the attachment, however, is the loose fit employed. When inserted into the disk slots the tips of the blades can be moved 0.020 to 0.030 in. in the tangential direction. Before the radial retaining pins are installed, the blades will drop out if the rotor is held with the axis vertical. The loose fit allows for differential expansion between the serrations on the blade roots and disk slots and permits the blades to seek positions minimizing the bending stresses arising from centrifugal loads. The chrome-molybdenum steel shaft is arc-welded to the first-stage disk while the second-stage wheel is attached with three $\frac{1}{2}$-in. bolts. The turbine rotor is supported on ball and roller bearings with the extra-clearance roller bearing located at the turbine or hot end. Fig. 6 illustrates the turbine rotor (first stage).

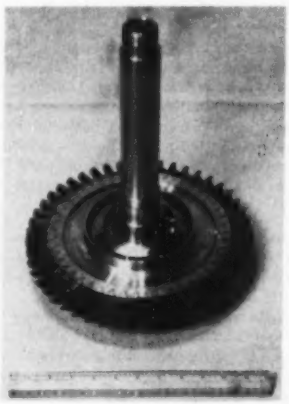

FIG. 6 TURBINE ROTOR

REDUCTION GEAR

A single pinion-and-gear combination reduces the speed from 20,138 rpm to that required by the generator. A set of accessory gears driven from the input pinion provides drives at 3358 rpm for each of the four accessory mounting pads, located for accessibility at the top of the gearbox.

LUBRICATION SYSTEM

High-speed antifriction bearings in gas-turbine service must be cooled as well as lubricated. One common method of cooling consists of directing upon the bearing a jet of compressor bleed air, to which a small amount of lubricating oil is added. Another method involves increasing the lubricating-oil flow to a point where it acts as a coolant as well as a lubricant. The latter method has been used widely with success in the field of aircraft turbosuperchargers and gas turbines, and on that basis was selected for this application. Results to date have been entirely satisfactory.

A 3.5-gpm vane-type pump draws oil from the 4-gal reservoir located in the reduction-gear casing, and pumps it through a micronic filter and an oil cooler consisting of a bank of finned tubes located in the air-inlet-silencer assembly. From the cooler, oil is distributed to the lubrication points in the gearbox and to the compressor and turbine shaft bearings, each of which receives approximately 1 qt per min of oil. The oil used is Navy Symbol 2075.

Transferring its heat to the compressor-inlet air may seem a costly way to cool the lubricating oil in view of the gas turbine's pronounced sensitivity in performance to inlet-air temperature; however, the relative magnitudes of the compressor air flow and the lubricating-oil heat rejection are such that the inlet-air temperature rise due to oil cooling is not prohibitive.

A scavenging element in the same housing with the oil-pump pressure element returns oil from the turbine rotor and aft compressor bearings to the reservoir, while the oil from the forward compressor bearing and gear trains returns to the reservoir by gravity.

STARTING SYSTEM

The large amount of starter power required to provide the specified rapid acceleration ruled out a conventional battery-driven electrical starter for this application because of the size and weight involved. Consideration of factors involved in the use of hydrogen peroxide, steam, solid propellants, and compressed air as energy sources for starting led to selection of high-pressure (3000 psi) compressed air as a medium. Ease of handling and availability of compressed air on board ship also influenced the selection. The air is stored in a tank of sufficient size to provide five normal starts. A pressure regulator reduces air pressure to 400 psi, after which it is directed at the second-stage turbine blading through a number of small jets. Although the power plant is self-sustaining at a lower speed, starting assist is maintained up to 55 per cent of rated rpm to provide rapid acceleration in the range where the margin of turbine power over compressor power is small.

FUEL AND CONTROL SYSTEM

A large portion of the developmental effort was involved in providing a control system which would fulfill the following requirements in the absence of operating personnel:

1 Initiate the starting cycle when normal ship's voltage fails.

2 Apply starting air, ignition, fuel, and generator excitation, and shut off starting air and ignition in the proper sequence.

3 Regulate fuel to the power plant during acceleration in accordance with a fuel flow versus speed relationship which will provide the maximum acceleration possible without producing compressor surge.

4 Govern the power-plant speed after rated rpm is reached and apply load.

5 Shut the power plant down and provide an annunciator signal, should malfunction such as excessive gas temperature, overspeed, or low lube-oil pressure occur.

The control system employs a 24-volt d-c circuit energized by a small storage battery. A Woodward multicontact speed switch, mounted outboard from the fuel pump, supplies signals

at 4000, 11,000, 20,000, and 22,000 rpm, thus providing the necessary sequencing. The speed-switch signals, together with those from the lube-oil underpressure switch and the exhaust-gas overtemperature switch, are fed into the turbine control box where a series of relays and timing motors provide appropriate controls.

The fuel system consists of a micronic filter, gear-type fuel pump, acceleration control valve, governor, and solenoid-operated shutoff valve preceding the fuel nozzle, Figs. 7 and 8.

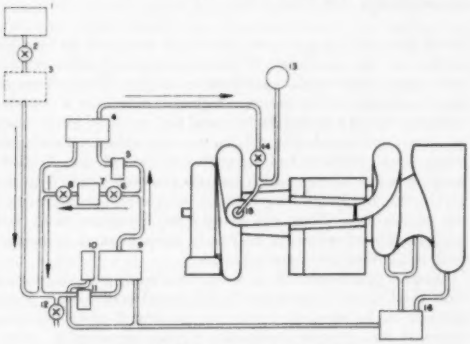

FIG. 7 FUEL-FLOW DIAGRAM

(1, Fuel tank; 2, shutoff valve; 3, boost pump (if used); 4, governor; 5, filter; 6, shutoff valve; 7, acceleration control valve; 8, metering valve; 9, fuel pump; 10, speed sequence switch; 11, filter; 12, drain valve; 13, fuel pressure gage; 14, shutoff valve; 15, fuel inlet; 16, drip tank.)

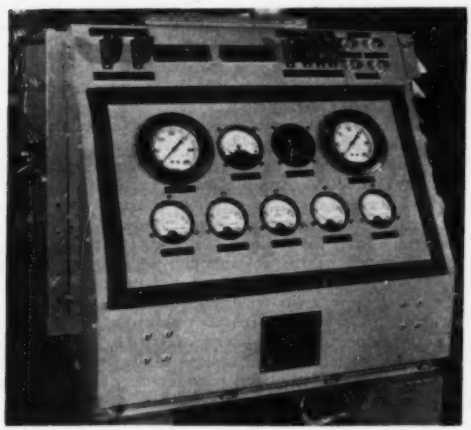

FIG. 8 CONTROL BOX

The fuel-pump delivery is greater than that required for any condition of operation. During acceleration the excess fuel is by-passed as necessary by the acceleration control valve which senses fuel-nozzle pressure, which in turn is proportional to speed, and thus provides the proper fuel-speed schedule. After rated speed is reached, the acceleration-control valve is removed from the system and a conventional Woodward flyball-type isochronous-speed governor by-passes fuel as necessary to maintain speed within the required limits.

SILENCERS

The principal source of objectionable noise in a shaft-output engine of this type lies in the compressor rotor blades and stator vanes. The level of high-frequency sound emanating from the compressor is reduced by a circular muff-type silencer fitted around the compressor inlet. Two concentric rings or splitters, made up of Fiberglas insulation encased in perforated aluminum sheet, are located in the air stream passing through the silencer. The silencer inner walls are insulated similarly. Lower-frequency sound in the turbine exhaust is reduced in intensity by means of a muffler designed along the lines of conventional reciprocating-engine muffler practice. Enlarged flow areas minimize pressure loss with the high volumetric flow passing through the muffler.

TEST PROGRAM

The test operation time accumulated prior to delivery served to point up and permit the correction of operational faults of the type discernible after short-time operation. However, it is recognized that the endurance properties of the equipment are not yet proved, particularly properties affected by factors such as vibration, thermal fatigue, stress rupture, and creep phenomena. The simple and to a large degree conventional mechanical design paid ample dividends in the remarkably trouble-free mechanical operation. Differential thermal expansion arising from the rapid starts and shutdowns resulted in various seal rubs; and minimum clearances had to be established largely on a cut-and-try basis. Replacement of the single labyrinth oil seals with double pressurized seals was found to be desirable. This eliminated the escape of lubricating oil in the form of oil mist when a pressure difference of more than a few inches of water was set up across the seals.

As of this writing, the gas-turbine engine has completed successfully approximately 90 hr of shore test operation and is now awaiting shipboard trials.

OTHER APPLICATIONS

In its present design form with the turbine, compressor, and output shafts mechanically coupled, the prime mover is suitable for substantially fixed-speed applications such as generator, pump, and compressor or blower drives. It is particularly suitable where use factors are low and space and weight are at a premium. By adding a third turbine stage not mechanically connected to the first two, and taking the power output from a reduction gear coupled to the third stage, torque multiplication becomes available. The prime mover would then be suitable for propulsion of land vehicles or small boats, and other variable-speed applications. Improvement in turbine efficiency, resulting in increased power output and improved economy, also would be associated with the use of three turbine stages.

THE first peat-burning gas turbine in the world is now running in the engineering shops of John Brown and Company, Glasgow, Scotland.

The plant consists of the firm's 500-hp experimental gas turbine which was first run four years ago on oil, and is now equipped with a peat-burning air heater and peat-drying and grinding equipment.

The plant is to undergo tests to determine the suitability of a peat-fired closed-cycle gas turbine for continuous operation to produce electric power. In its present form it can run on peat of any moisture content up to 50 per cent, but next year the firm will construct further drying equipment to enable the plant to take peat of a higher moisture content without loss of efficiency.

INDUSTRY'S LAST CHANCE

To Prevent Government Control in the Field of Industrial Safety

By CYRIL AINSWORTH

TECHNICAL DIRECTOR, AMERICAN STANDARDS ASSOCIATION, NEW YORK, N. Y.

THE AMERICAN WAY OF DOING THINGS

THE political, economic, and social problems facing the country are constantly in the minds of all who are concerned about the future of the United States of America. Individuals, industrial and labor groups, women's organizations, religious organizations, politicians, governmental officials and agencies, and special bodies created to study special problems are devoting much of their time, activity, and money to serious, conscientious, honest investigations and planning in the solution of these problems. This is the American way of doing things. It is the way in which our national and local problems have been solved throughout the entire history of the country, and so long as it continues, and so long as fundamental American principles are the basis of such thinking and action it would seem as though the future will safely take care of itself. The danger will arise when such constructive thinking stops, or when individuals and groups become so wrapped up in selfish considerations that they fail to keep in mind the needs of the country as a whole or when they become solely negative in their approach to the problems. No individual, group, or activity can shirk his or its responsibility in seeing that such dangers are avoided.

What has all this to do with accident prevention and its role as one of the fundamental responsibilities of management? It might be indicated through the title of this paper that management and its special assistant and adviser, the safety engineer, are failing to exercise their responsibilities. Maybe this is so and maybe it is not, but it is suggested that some recent events indicate that the question be considered. It is the purpose of this paper to do so.

While some of the events which suggested this discussion occurred in connection with the work of the organization with which the author is officially connected, the thoughts expressed are solely those of the author. They are based on his activities in accident prevention over a period of more than thirty years, including industrial, governmental, and public-service organization work and experiences. Likewise, it is not likely when this discussion has been completed that all who may hear or read will agree with the author. If, however, further thinking and discussion are stimulated and constructive action is taken by those concerned, the paper will have served a useful purpose.

PRESIDENT'S CONFERENCE ON INDUSTRIAL SAFETY

In the field of accident prevention no activity in recent years has been more controversial than that represented by the President's Conference on Industrial Safety. The first announcement that such an activity was to be organized and carried on for a period of years, maybe permanently, was almost atomic in its reception by many individuals and groups. The fact that it followed a President's Conference on Highway Safety which had been well organized and conducted and which had been well received didn't lessen the fears of those who believed that this new activity had been conceived by special-interest groups as a means of placing control of industrial accident-prevention work in government hands. Thirty-thousand deaths per year on the nation's highways was truly a national calamity which justified Presidential and national government concern. Industrial safety, however, was industry's responsibility which industry had accepted and worked on. Furthermore, it was a matter which had always been handled on the local level, and Federal intervention into a local problem could not be justified. These and many other thoughts, ideas, and arguments were advanced to justify unwillingness to participate or "cold-water" participation.

On the opposite side there were those who, while regretting that the Federal Government had believed it necessary, in the interest of the national welfare, to do something to stimulate renewed or greater industrial accident-prevention work, thought that industry, business, labor, and government should accept the new operation as a new opportunity for a co-operative approach to the problems involved. There were some who knew that industry had made great progress over the years but thought that possibly more progress might be made if the problem could be examined from a new vantage point such as that presented by the conference. There were others who believed that the basic responsibility for governmental operations rests in the people who created government and, therefore, all should participate in the conference to the best of their ability to insure the success of the conference in terms of the best American principles.

These differences of opinion were expressed in good American style. The conference proceeded with its work; committees on assigned subjects were organized. Meetings were held and reports developed. Work is continuing, and additional conferences will be held next year. The big question as to whether the conference has been or will be successful still remains to be answered. So far the President's Conference, in the way it has been conducted by the governmental agencies and officials charged with that responsibility, has shown no tendency to drive for control of the accident-prevention activities of the country. It has shown no tendency to usurp the prerogatives of any other organization. It has not operated to get support for legislation designed to give agencies of the Federal Government any control or regulatory or enforcement powers. It has operated in true free-enterprise methods of co-operative work between industry, labor, and Government.

MANAGERIAL POLICY

So far in this discussion sides have not been taken on the opinions expressed or attitudes assumed. These are matters of the past. But on the question as to whether the Conference has been or will be successful a firm position is taken. It is that the success or failure of the Conference rests largely upon the shoulders of industry, through the policies formulated by management and executed by its representatives, the safety engineers.

Through the work of its committees the Conference has es-

Contributed by the Safety Committee and presented at the Annual Meeting, Atlantic City, N. J., November 25–30, 1931, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

tablished policies, programs, and practices which are presented for the voluntary use of all concerned. Management through its representatives has agreed to these policies and programs. Otherwise they wouldn't be in existence. What does management intend to do about the recommendations? Did management agree to them for the purpose of indicating co-operation? Did it agree to them expecting after they were put on paper to do nothing with them? Or, on the other hand, did it agree to them because they were reasonable and constructive suggestions which might be tried out? Did it agree to them with the understanding that, because accident prevention is a function of management, management has a responsibility to use any constructive tool which is offered to help in the prevention of accidents, a responsibility which is pertinent not only to the individual plant involved but to the industry with which it is affiliated, and to the economic and social advancement of the country as a whole? This latter series of questions would appear to represent the constructive approach which if followed will afford to management many continuing chances for constructive service.

It is with gratification that it can be said that such opportunities have been accepted and that many of the policies and programs of the conference are being put into use. The small-plant, trade-association, and government-agency programs of the National Safety Council are good examples to prove the point. The recommendations on the very ticklish subject of labor-management relations in safety are being tried out.

Among other policies and programs agreed to in the President's Conference are some which affect vitally the important relations of industry and government, and it is in connection with these matters that management's future actions will dictate whether it has continuing chances for voluntarily exercising its responsibilities or if the present is industry's last chance.

DEVELOPMENT AND USE OF SAFETY CODES

The subject discussed most frequently in the various sessions of the Conference was the establishment of regulations at the local level based upon codes developed under the procedures of the American Standards Association and known as American Standard Safety Codes or American Safety Standards. Practically every committee of the Conference touched upon this subject in one way or another. The Committee on Laws and Regulations and the Committee on Engineering were the points of sharpest discussion. The actions of these committees as reported to the general sessions placed sharp pressure on state and municipal regulatory bodies to use American Standard Safety Codes as the basis of any regulations which might be adopted. The discussion on the floor of the first general session further emphasized this point. It is clear from the records that definite reasons existed for this policy. Among them might be mentioned:

(*a*) The lack of uniformity in government regulations costs industry many thousands of dollars annually, through its inability to use standard procedures in conducting its operations, and its inability to buy goods and equipment at the lowest possible cost and so designed and manufactured as to provide maximum protection to those using them.

(*b*) Industry and labor are subject to unnecessary costs of doing business because of the necessity for attendance at public hearings held by states and municipalities to present arguments as to the value, stringency, adequacy, and enforceability of proposed regulations. The use of American Standard Safety Codes by many regulatory bodies has saved industry and labor these costs. More extensive use would increase the savings.

(*c*) The membership of the conference was quite familiar with the process of developing American Standard Safety Codes, because the industrial, labor, insurance, governmental, and technical groups represented in the Conference had been working on the development of codes under ASA procedures for the past thirty years.

(*d*) The codes are one of the best source of technical information on the subjects covered to be found anywhere in the United States.

(*e*) The codes are reasonable and practical and, because of their acceptance under ASA procedures by all groups concerned, the regulatory body has assurance as to their enforceability and acceptability.

The discussions in the Engineering Committee and on the floor of the general Conference called for the development of codes on subjects for which no standards exist. The Engineering Committee in its report called upon ASA to make a survey of the need for new safety codes and to initiate projects for the development of codes as might be found desirable. The demands for new codes which were made on the floor of the general sessions were very emphatic and were made with the strong implication that if the normal leadership of industry in accident-prevention work would not be forthcoming in the studies recommended by the Engineering Committee and new codes were not developed for subjects not covered by existing codes, other means for their development would be found.

Industry and management through their representatives on the Engineering Committee had agreed to the inclusion in the report of the request that ASA make a study of the need for new codes. In this connection it should be recalled that industry generally has viewed with increasing concern the ever-expanding regulation of business. This is a matter about which we should all be concerned and the word "all" includes labor, technology, and government, as well as business. Many in the field of management have been concerned lest the development of codes would result in increasing regulation of business by governmental agencies. Therefore the suggestion to ASA that a survey of the need for new codes be made represented a definite challenge which had to be met square on.

INDUSTRY THROUGH ASA ACCEPTS CHALLENGE

Because of the importance of the matter, the request of the President's Conference was presented to the topmost technical body in ASA, the Standards Council, for consideration. The council is composed of the representatives of the broad membership of the organization. Here was the place where the top policy decision could be made. The council responded to the challenge and directed its Safety Code Correlating Committee to conduct the survey and report to the President's Conference on Industrial Safety. By this action the membership of ASA which, generally speaking, represents the main body of American industry and business, decided again that both safety and standardization are functions of management and that industry under voluntary operations has the responsibility for conducting such activities in such a way as will meet with the greatest success in the public interest.

The Safety Code Correlating Committee appointed a special committee for the purpose of the survey. Its membership included representatives of industry, government, labor, insurance, technology, and public-interest groups so that its report represents the composite thinking of all segments of industrial life and of accident-prevention work. The report of the special committee as approved by the Safety Code Correlating Committee contained the following recommendations:

(*a*) That more extensive effort be given to the promotion of the use of existing American Standard Safety Codes.

This corresponded with recommendations of the President's Conference but was intended to emphasize to industry, labor,

and government that much good technical material existed which had not been fully used.

(*b*) That new promotional material described in the scope and content of existing codes be published and made available for use, particularly among those groups not too familiar with the American Standard Safety Code program. As the main point in this recommendation it was suggested, because codes contained many individual standards, an index be prepared in as great detail as possible. This would be of very great value in indicating the wealth of technical material which all of the codes contained.

(*c*) That certain projects which had been inactive be reactivated and revisions be undertaken of some of the standards which seem to be out of date.

(*d*) That inasmuch as industry had in its possession much technical material which might be used as a basis of codes, ASA invite industry to send such material to it in order that it might be considered by the groups directly concerned in the development of new codes.

The first three of these recommendations speak for themselves, but the last recommendation is exceedingly important because its fulfillment, or lack of fulfillment, may very easily cast the die as to the direction in which government will operate in the future.

Much of the technical material which industry has assembled has been published in bulletin form and therefore it is well known that such technical material exists. All of it may not be suitable for use in the development of codes which might be used as the basis of government regulations. It is well recognized that some material of the "safe-practice" nature should not be included in regulations which are enforceable and have the effect of law. Such material is normally included in "Data Sheets" and "Safe-Practice" pamphlets of the National Safety Council. Nevertheless, the technical material of industry does contain recommendations which can safely be used as a guide to governmental agencies in the establishment of regulations by its inclusion in American Standard Safety Codes.

THE NEXT STEP

But the big question remains as to whether industry will examine these recommendations with broad vision and constructive spirit. Will it accept its responsibility to the American system of voluntary action and, through the building of appropriate technical recommendations, through procedure which industry has established itself and found fully effective in coordinating its own points of view with those of labor and government, make effective for all concerned codes which can truly be called American Standard. Should industry fall back on its own old antagonisms to codes with the fear that such material will be enforced against it by regulatory bodies using the codes as the basis of regulations, it can very well be that the rejection of this new opportunity may be the last chance for effective and constructive voluntary approach to industrial accident-prevention work.

The report of the Safety Code Correlating Committee has been forwarded to The President's Conference on Industrial Safety; it has been reviewed by the Engineering Committee, which has expressed satisfaction with it. Reference is made to it in the latest edition of the report of the Engineering Committee. Therefore everyone interested in the over-all problem will be watching to see what management's policy will be in carrying out the recommendations which it has already agreed to.

LABOR'S RESPONSIBILITY

Lest this discussion be misunderstood from the point of view that it might be indicated that responsibility for the development of safety codes and for the maintenance of the voluntary system of American industrial operation rests solely upon the shoulders of management, it must be said that labor also cannot escape its responsibilities in the matter. There is no question but that the agitations of labor for more appropriate working conditions have done much to stimulate accident-prevention work. There have been times when it has appeared as though labor believed that nothing had been done. This is undoubtedly part of its propaganda technique because it cannot close its eyes to the fact that if industry had not been vigorous in pursuing accident-prevention work during the past thirty-five years, the present toll of accidents on the highways would seem rather small compared with what the industrial rate would be.

The time has come when labor must couple its agitations for more and more accident-prevention work with constructive action of its own. There are signs that this point of view is understood in some labor circles. Some labor unions are building accident-prevention programs, but that start at the moment is on a very small scale indeed. Labor can do much to educate its own people as to their responsibilities, the responsibility of the individual workman to those with whom he is associated in his daily operations. The best techniques in performing tasks are those which will permit the task to be carried out without accident. Labor can institute courses in self-improvement in task operations which can instill the safety habit in the minds of the worker. Labor should not fail to seek the co-operation of management in the establishment of such courses in order that the best possible technical instructions will be available. These are just a few of the ideas which might be enumerated to indicate avenues of approach whereby labor can assume much responsibility for future accident-prevention work in industry.

CONCLUSION

To get back to the safety-code program, this discussion should not close without a few words as to what further action might be taken, assuming that industry decides that it will take the constructive and broad position which has been outlined. American Standard Safety Codes are of no value unless they are used. Governmental operations are just what the people make them. State and municipal regulatory bodies can be operated free from the many criticisms which one hears in discussions of governmental operations if industry and labor are willing to do their share in the conduct of such agencies. There is ample evidence to the effect that ineffective inspections, inappropriate interpretation of law and regulation, promulgation of ineffective standards and requirements, can be stopped if industry and labor will join forces with the government officials in authority and plan programs which are constructive and of value to the industrial life of the community. Throughout the whole period of the history of labor-law development, application, and enforcement, co-operative work by the various groups which make up the industrial life of the community has made the governmental agency a true servant of the people not only in the saving of human life, but in industrial development, maintaining employment, and social improvement.

Industry has put much time, effort, and money in the formulation of American Safety Standards but has given only a small amount of time to the promotion of their use. If the governmental agency and official are advised as to what industry wants or as to what it considers right and appropriate, they will in most cases listen. A drive by industry to encourage government to revise existing regulations to meet American Standard Code requirements and to use the codes in the development of new regulations could produce marvelous results.

THERMAL PERFORMANCE *of* MODERN TURBINES

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NOMENCLATURE

The following nomenclature is used in the paper:

F = Throttle flow, lb per hr
SH = superheat, deg F
R = reheater flow, lb per hr
C = condenser flow, lb per hr
E = extraction flow to heater, lb per hr
HR = heat rate, Btu/kw/hr
kw = kilowatt output at generator terminals
H_1 = initial enthalpy, Btu per lb
H_F = final feed enthalpy, Btu per lb
H_R = reheated-steam enthalpy, Btu per lb
H_E = high-pressure turbine-exhaust enthalpy, Btu per lb
$H_R - H_E$ = heat added in reheater, see Fig. 16
K = reheater flow factor. Use 0.91 of throttle flow for a five-stage heater arrangement when top heater is receiving steam from line returning steam to heater. Use 0.86 for six stages of extraction when top heater is receiving steam from extraction zone above return to heater as shown in Fig. 7.

INTRODUCTION

The purpose of this paper is to provide data on the heat rates that can be expected from turbine-generator units of 75,000 to 200,000 kw capability operating with the regenerative steam cycle, with various steam conditions beginning at 850 psig 900 F, and extending through 2400 psig 1100 F and various stages of feedwater heating. Similar information is provided for turbine-generator units operating with the combined regenerative and resuperheating cycles. Means are provided for calculating the turbine throttle steam flow at capability output together with the corresponding flow to the condenser and the quantity of steam extracted for feedwater-heating purposes. Charts are provided to show the heat added per pound of steam in the reheater for units operating on the resuperheating cycle.

Data are given for two sets of recently used steam conditions of 1450 psig 1000 F and 1800 psig 1050 F to show the reduction in heat rate obtained for various stages of feedwater heating together with the optimum final feed temperature.

The heat-rate data presented are not necessarily the best obtainable but are reasonable values that can be expected from modern turbines in actual practice and represent the current development of the art.

These data together with other published information[2] on turbine-generator units of 12,650 to 100,000 kw capability show the relationship between varying steam conditions, turbine sizes, and types. This permits steam conditions and turbine kw ratings to be evaluated accurately for operating hours and fuel cost to determine their economic values.

EARLY STUDIES

About 11 years ago the job of organizing and rationalizing large turbine efficiencies for submission to the steam-power industry was begun. At that time, importance was placed on straight condensing turbine-generator efficiencies or steam rates rather than on heat rates. With straight condensing steam rates defining the efficiency of the turbine, it was possible to calculate feed-heating heat rates readily when supplied with condition lines, leaving loss, and mechanical and electrical loss data. However, an almost endless number of feed-heating cycles is possible, which results in as many turbine heat rates. For a specific heater arrangement, temperature rise, distribution, terminal difference, pressure drop, and final feed temperature, it is possible to tabulate heat rates for various turbine sizes, steam conditions, and number of feed-heating stages. Variations in the feed-heating cycle, such as use of drain coolers, desuperheating sections, or varying heater terminal difference for a given number of heaters and a specific final feed temperature, rarely affect the heat rates by more than 1 per cent.

STANDARDIZATION OF STEAM CONDITIONS

Many combinations of steam pressures and temperatures are available, and have been used in the past. However, of the hundreds of thousands of kilowatts of turbine capacity purchased prior to 1940, practically all of them can be grouped into four general classes of initial steam conditions, as follows:

400 psig, 750 F (301.9 F SH)
600 psig, 825 F (336.2 F SH)
850 psig, 900 F (372.7 F SH)
1250 psig, 950 F (376.1 F SH)

These permitted a choice of four steam conditions, any one of which could result in economical steam plants. They are well matched to give reasonable moisture conditions in the lower-pressure turbine stages with resultant long exhaust-end blade life.

Selection of four rational initial steam conditions made it possible to calculate, tabulate, and analyze the hundreds of turbine propositions and test results of the past years. This was expedited by correcting and referring all straight condensing turbine efficiencies to a common value of 300 F superheat.

SUPERHEAT CORRECTION FACTORS

Superheat correction factors have been established for years, particularly for the higher ranges, that is, 200 F or higher. The superheat correction factors used for straight condensing efficiencies are given in Table 1. This information in curve form is shown in Fig. 1.

[1] Mem. ASME.

[2] Performance Data 1260. Condensing Turbine Generator Units. 12,650-Kw to 100,000-Kw, inclusive, AIEE-ASME Preferred Standard Rating, Westinghouse Electric Corporation, June, 1951.

Contributed by the Power Division and presented at the Annual Meeting, Atlantic City, N. J., November 25–30, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

TABLE 1 SUPERHEAT CORRECTION FACTORS

Superheat, deg F	Correction factor
0	0.926
100	0.959
200	0.983
250	0.992
300	1.000
350	1.007
400	1.013
500	1.023

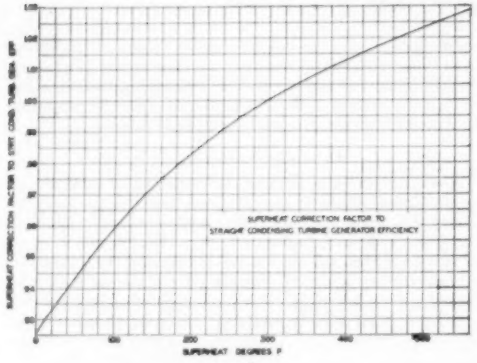

FIG. 1

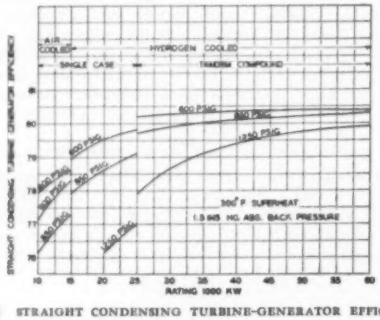

FIG. 2 STRAIGHT CONDENSING TURBINE-GENERATOR EFFICIENCY

RATIONALIZATION OF STRAIGHT CONDENSING TURBINE-GENERATOR EFFICIENCIES

With superheat correction factors the remaining unknown factors were the effect of steam pressure and turbine kw rating on efficiency.

Turbine efficiency increases with larger steam flows. Increasing steam pressure for the same kw rating reduces volumetric flow with the corresponding reduction in efficiency. The specific effect of these variables required hundreds of calculations and rationalization of values.

The straight condensing turbine-generator efficiencies were plotted for the four basic steam conditions with kw-rating and turbine efficiency as the co-ordinates. These data are shown in curve form in Fig. 2. Similar data were calculated for exhaust pressures of 1.0, 2.0, and 2.5 in. Hg abs. By cross-plotting these data, vacuum correction curves were obtained, Fig. 3.

An informative curve of straight condensing turbine efficiency was a plot of steam pressure and turbine efficiency as co-ordinates with turbine ratings as parameters for constant superheat of 300 F. Fig. 4 is typical of the data for an absolute back pressure of 1 in. Hg.

This information was put into tabular form and since has been used for calculating straight condensing steam rates for turbine-generator units. Factors permitting establishment of partial-load straight condensing steam rates were also determined. Straight condensing steam rates for ratings of 10,000 through 60,000 kw for four steam conditions and three exhaust pressures, calculated from these data, are shown in Table 2.

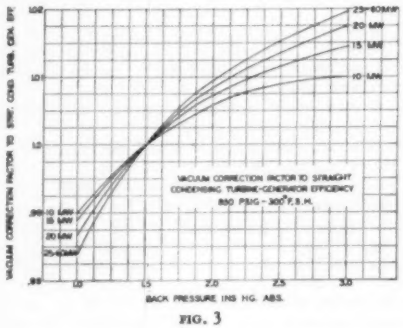
VACUUM CORRECTION FACTOR TO STRAIGHT CONDENSING TURBINE-GENERATOR EFFICIENCY
850 PSIG - 300° F.S.H.
BACK PRESSURE INS. HG. ABS.

FIG. 3

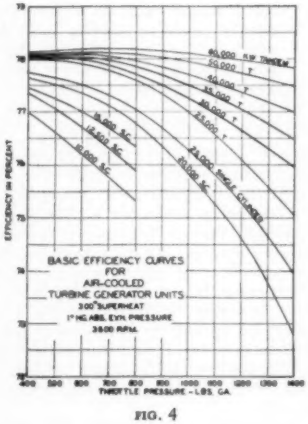
BASIC EFFICIENCY CURVES FOR AIR-COOLED TURBINE GENERATOR UNITS
300° SUPERHEAT
1" HG. ABS. EXH. PRESSURE
3600 R.P.M.
THROTTLE PRESSURE - LBS. GA.

FIG. 4

With straight condensing heat rates as a basis, Reynolds[3,4,5] developed curves which gave the improvement in heat rates with various numbers of feedwater-heating stages. These data made it possible to estimate regenerative feedwater heat rates from straight condensing heat rates.

TURBINE-GENERATOR HEAT-RATE DATA

By using straight condensing heat rates and Reynolds curves, turbine-generator heat rates could be tabulated for a

[3] "Calculation of the Gain From Feedwater Heating," by R. L. Reynolds, *Electric Journal*, vol. 26, 1929, pp. 153–157.

[4] "Calculation of the Gain From Three-Stage Feedwater Heating," by R. L. Reynolds, *Electric Journal*, vol. 26, 1929, pp. 224–226.

[5] "Factors Which Affect the Gain From Feedwater Heating," by R. L. Reynolds, *Electric Journal*, vol. 26, 1929, pp. 282–285.

TABLE 2 STRAIGHT CONDENSING STEAM RATES

Kw rating	In. Hg abs			In. Hg abs		
	400 psig, 750 F			600 psig, 825 F		
	1.0	1.5	2.0	1.0	1.5	2.0
10000	8.90	9.16	9.37	8.28	8.49	8.66
15000	8.89	9.08	9.25	8.20	8.36	8.51
20000	8.52	8.98	9.15	8.09	8.23	8.37
25000	...	...	...	8.08	8.20	8.33
	850 psig, 900 F			1250 psig, 950 F		
	1.0	1.5	2.0	1.0	1.5	2.0
10000	7.81	7.97	8.12	...	...	...
15000	7.68	7.85	7.98	...	...	...
20000	7.59	7.71	7.83	7.58	7.69	7.80
25000	7.56	7.67	7.78	7.50	7.60	7.70
30000	7.49	7.60	7.70	7.35	7.44	7.54
35000	7.48	7.58	7.69	7.30	7.39	7.49
40000	7.47	7.57	7.68	7.27	7.37	7.46
50000	7.46	7.56	7.66	7.24	7.34	7.43
60000	7.45	7.55	7.65	7.25	7.32	7.42

whole range of turbine sizes and steam conditions. By providing basic data of turbine-generator units, such as throttle flow, condenser flow, final feed temperature, and heat rate, it was hoped that there would be a better understanding of the economic application of turbine-generator units.

This information was worked out, tabulated, and printed in book form.[6] This book was printed and distributed as a contribution to the steam-turbine industry. It served a fundamental purpose as it clearly set forth the heat rates obtained with various numbers of feedwater heaters from 0 to 5 stages, and for turbine ratings from 10,000 to 60,000 kw with four initial steam conditions and three exhaust pressures.

All heat-rate calculations were based upon the following formula

$$HR = \frac{F(H_1 - H_F)}{kw} \quad \ldots\ldots\ldots\ldots [1]$$

The power required by the boiler feed pump and the rise in liquid enthalpy due to compression, the heat absorbed in the air-ejector condenser, hydrogen or air coolers, and oil coolers was not included in the heat-balance calculations for the book referred to[5] nor for any of the heat-balance calculations in this paper.

This booklet is still a useful engineering tool, even though the highest steam conditions listed are 1250 psig 950 F, and the largest turbine rating 60,000 kw. Today, however, single-shaft 3600-rpm turbine-generators of 150,000 kw capability, as shown in Fig. 5, will be shipped soon, and single shaft ratings of 185,000 and 200,000 kw already have been undertaken. Steam conditions for turbine ratings as low as 60,000 kw are quite commonly 1450 psig 1000 F, with and without reheating. Steam pressures for larger ratings vary upward to 1800 psig, or 2000 psig. One 3600-rpm turbine of 185,000 kw capability is being designed for steam conditions of 2350 psig 1100/1050 F. Furthermore, today little importance is attached to straight condensing efficiencies since the heat consumption of turbine-generator units in Btu/kw/hr is of more direct interest.

HEAT RATES FOR HIGHER STEAM CONDITIONS

Extension of data in the book on steam power-plant planning[6] to cover the higher temperatures and pressures currently used was clearly indicated.

There has not been sufficient time to provide this extended heat-rate data in tabular form or to revise the work in the book. However, the heat rates of large turbines from 75,000 to 200,000 kw have been calculated and are presented in curve form for the following five basic well-matched steam conditions:

850 psig, 900 F, 1.5 in. Hg abs
1250 psig, 950 F, 1.5 in. Hg abs
1450 psig, 1000 F, 1.5 in. Hg abs
1800 psig, 1050 F, 1.5 in. Hg abs
2400 psig, 1100 F, 1.5 in. Hg abs

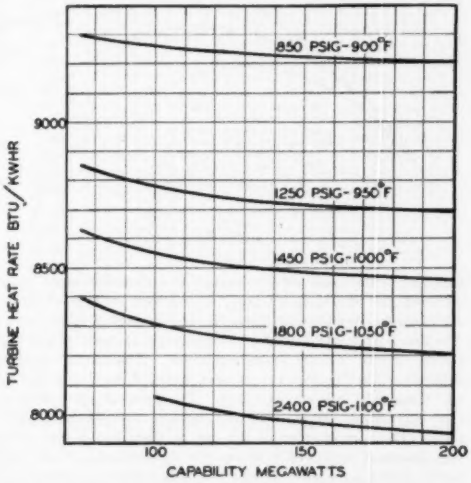

FIG. 6 TURBINE HEAT RATE VERSUS CAPABILITY LOAD FOR NON-REHEAT TURBINE-GENERATOR UNITS
(Five stages feedwater heating, exhaust pressure 1.5 in. Hg abs.)

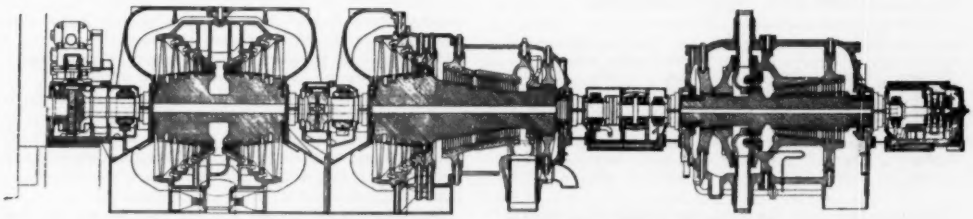

FIG. 5 TANDEM-COMPOUND TRIPLE-FLOW 135,000-KW REHEAT TURBINE
(1800 psi 1000 F total temperature, 1.5 in. Hg abs; 3600 rpm; reheat to 1000 F total temperature; maximum capability 150,000 kw.)

[6] "Steam Power Plant Planning Guide," Westinghouse Electric Corporation, Bulletin B-3153 A, 1945.

Fig. 6 shows the turbine heat rates at kilowatt capability of turbine-generator unit for these five basic steam conditions which are based on the heat-rate Equation [1]. This information is shown for constant exhaust pressure of 1.5 in. Hg abs and five stages of feedwater heating.

The heat rates are based on a five-stage regenerative feedwater-heating arrangement similar to that shown in Fig. 7, except for omission of reheating and the sixth heater. In this arrangement the feedwater is pumped from the main condenser by a condensate and boiler feed pump through five closed heaters before entering the steam generator. The drains from each heater are cascaded to the next lower heater through a drain cooler. The drain from the lowest pressure heater is cascaded through a drain cooler to the main condenser. The heater terminal difference for the top heater was assumed as 0 deg and for the remaining heaters as 5 deg. The pressure drop between the extraction flanges and the heaters was taken as 5 per cent. The temperature of the drains from the drain coolers was assumed to be 10 F above the temperature of the feedwater entering the drain cooler. The heat-balance calculations for the various steam conditions were based upon a final feedwater temperature at turbine capability as given in Table 3.

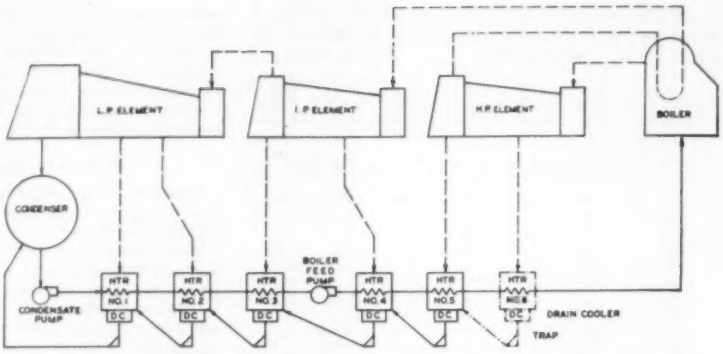

FIG. 7 GENERAL ARRANGEMENT OF BASIC ELEMENTS OF A REHEAT-REGENERATIVE STEAM CYCLE

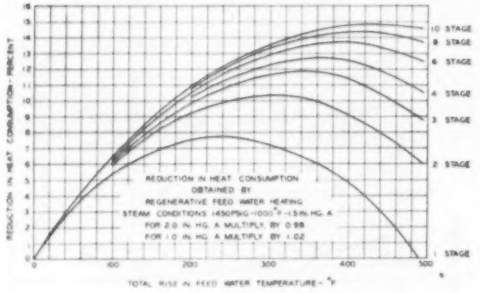
REDUCTION IN HEAT CONSUMPTION - PERCENT
TOTAL RISE IN FEED WATER TEMPERATURE - °F
10 STAGE
9 STAGE
6 STAGE
4 STAGE
3 STAGE
2 STAGE
1 STAGE
REDUCTION IN HEAT CONSUMPTION OBTAINED BY REGENERATIVE FEED WATER HEATING
STEAM CONDITIONS 1450 PSIG-1000 °F-1.5 IN. HG. A
FOR 2.0 IN. HG. A MULTIPLY BY 0.98
FOR 1.0 IN. HG. A MULTIPLY BY 1.02

FIG. 8

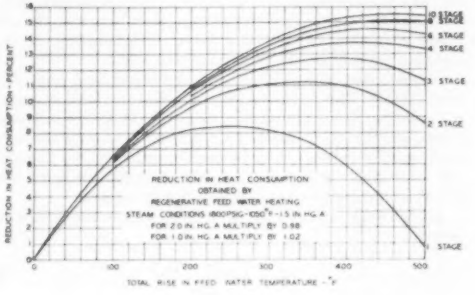
REDUCTION IN HEAT CONSUMPTION - PERCENT
TOTAL RISE IN FEED WATER TEMPERATURE - °F
9 STAGE
8 STAGE
6 STAGE
4 STAGE
3 STAGE
2 STAGE
1 STAGE
REDUCTION IN HEAT CONSUMPTION OBTAINED BY REGENERATIVE FEED WATER HEATING
STEAM CONDITIONS 1800 PSIG-1050 °F-1.5 IN. HG. A
FOR 2.0 IN. HG. A MULTIPLY BY 0.98
FOR 1.0 IN. HG. A MULTIPLY BY 1.02

FIG. 9

TABLE 3 INITIAL ENTHALPY AND FEED ENTHALPY FOR SOME BASIC STEAM CONDITIONS

Steam conditions: Initial steam conditions — Pressure, psig	Temp, deg F	Enthalpy, H_i	Saturated temp, deg F	Feedwater to boiler — Final feed temp, deg F	Enthalpy, H_F
850	900	1453.1	527.3	400	375.0
1250	950	1468.0	573.9	435	413.3
1450	1000	1491.1	593.0	450	430.1
1800	1050	1510.9	622.1	475	458.6
2400	1100	1525.5	663.0	500	487.8

The heat rates are based on our custom of providing 5 per cent steam-flow margin over capability load at 2.5 in. Hg abs exhaust pressure to cover variations in manufacturing. Flow margins greater than expected may have an adverse effect on the turbine heat rate.

CALCULATIONS AND CORRECTIONS

Throttle-Flow Calculations. For a given kw rating, initial steam conditions, final feed temperature, and heat rate, it is readily possible to calculate the throttle flow at capability from the following formula

$$F = \frac{\text{HR} \times \text{kw}}{H_i - H_F} \quad \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

Curves similar to those printed in the guide on steam power-plant planning[5] were calculated for steam conditions of 1450 psig 1000 F, 1.5 in. Hg abs, and 1800 psig 1050 F, 1.5 in. Hg abs, showing the optimum final feed temperature and the reduction in heat rate for various numbers of feedwater heating stages as shown in Figs. 8 and 9. Also for these higher steam conditions, curves were prepared to show the quantity of steam extracted in per cent of throttle flow for various numbers of feedwater heating stages as shown in Figs. 10 and 11.

Table 4 was prepared to show the heater extraction factors for determining the flow to each heater for the feed-heating arrangement shown in Fig. 7, omitting the reheater. The heater flows are calculated by taking the factors tabulated under the number of stages times the difference in the throttle and condenser flows which is the total steam extracted.

The initial enthalpy and feed enthalpy for the five basic steam conditions are given in Table 3 for use in subsequent calculations.

TABLE 4 HEATER EXTRACTION FACTORS FOR EQUAL ENTHALPY RISE OVER EACH HEATER FEED-HEATING ARRANGEMENT AS SHOWN IN FIG. 7 NONREHEAT UNITS

No. stages feed heating	Heater number									
	1	2	3	4	5	6	7	8	9	10
1	1.000									
2	0.461	0.539								
3	0.288	0.328	0.384							
4	0.215	0.234	0.258	0.293						
5	0.171	0.183	0.197	0.214	0.235					
6	0.139	0.148	0.158	0.171	0.184	0.200				
7	0.114	0.121	0.130	0.141	0.152	0.164	0.178			
8	0.098	0.104	0.110	0.118	0.127	0.137	0.147	0.159		
9	0.085	0.090	0.095	0.101	0.108	0.116	0.125	0.135	0.145	
10	0.076	0.080	0.085	0.090	0.095	0.100	0.106	0.114	0.122	0.132

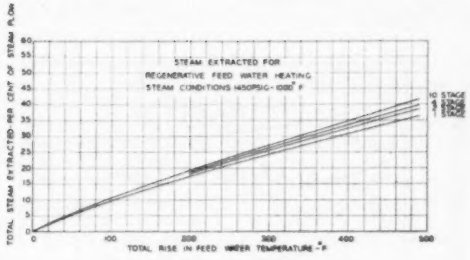

FIG. 10

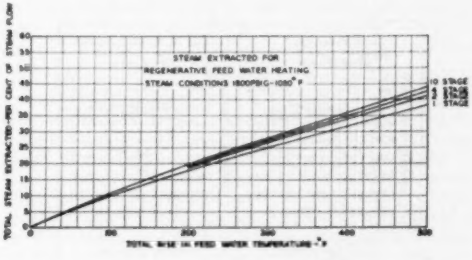

FIG. 11

For example, assume a rating of 80,000 kw with a capability of 100,000 kw for steam conditions of 1450 psig 1000 F, 1.5 in. Hg abs, five stages of feed heating, and a final feed temperature of 450 F. Using the heat rate from Fig. 6, the throttle flow is as follows

$$F = \frac{8550 \times 100{,}000}{1491.1 - 430.1} = 805{,}800 \text{ lb per hr}$$

Condenser-Flow Calculations. The condenser flow is 1 minus the factor from Fig. 10 times the throttle flow

$$C = (1 - 0.308)\ 805{,}800 = 557{,}600 \text{ lb per hr}$$

Heater-Flow Calculations. The extraction flows to each heater are the factors listed under five stages in Table 4 times the total extracted flow as follows:

Heater no.

1 $E_1 = 0.171 \times 0.308 \times 805{,}800 = 42{,}440$
2 $E_2 = 0.183 \times 0.308 \times 805{,}800 = 45{,}420$
3 $E_3 = 0.197 \times 0.308 \times 805{,}800 = 48{,}890$
4 $E_4 = 0.214 \times 0.308 \times 805{,}800 = 53{,}110$
5 $E_5 = 0.235 \times 0.308 \times 805{,}800 = 58{,}320$
248,180

Variations From Base Conditions. For steam conditions varying from the five basic ones in Fig. 6, correction factors are provided to correct heat rates for initial pressure, initial temperature, exhaust pressure, number of stages of feed heating, and terminal difference on top heater.

Initial-Pressure Correction. The initial-pressure correction to heat rate for a plus or minus change in pressure of 100 psi is shown in Fig. 12. For an increase of 100 psig from a given base, multiply the heat rate in Fig. 6 by a correction factor, and for a decrease, divide the heat rate by the correction factor. For example, the improvement in heat rate in changing from 1800 psig to 1900 psig of a 150,000-kw unit is obtained by multiplying the heat rate from Fig. 6, 8220 × 0.9961 which is 8188.

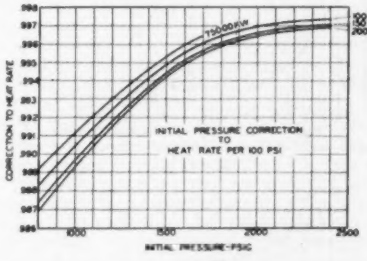

FIG. 12

Initial-Temperature Correction. The initial-temperature correction to heat rate for 25 and 50 F variation in temperature is shown in Fig. 13 for nonreheat units. For an increase of 25 or 50 F, multiply the heat rate from Fig. 6 by the correction factor. For a decrease of 25 or 50 F, divide the heat rate by the correction factor.

Correction for Number of Stages Feed Heating. The correction to heat rate for various numbers of stages of feed heating is shown in Fig. 13. For any other stages of feedwater heating than five, multiply the heat rate in Fig. 6 by the correction factor.

Exhaust-Pressure Correction. The approximate exhaust-pressure correction to heat rate is shown in Fig. 13. For exhaust pressures other than 1.5 in. Hg abs, multiply heat rate by the correction factor. It is to be noted that the exhaust correction factors are considered only approximate but do represent reasonable corrections for heat-rate studies.

After the turbine heat rates have been corrected to the new steam conditions, throttle and condenser flows can be calculated from Equation [2] as shown in the previous example.

Correction for Terminal Difference on Top Heater. The correction to heat rate for terminal difference on the top heater is shown in Fig. 14. For terminal difference varying from 0 deg multiply

the heat rate in Fig. 6 by the correction factor. Note correction factor decreases with increasing final feed temperature.

Heat Rates for Reheat Units. Fig. 15 shows the heat rates of large reheat tubines from 75,000 to 200,000 kw in curve form for four basic well-matched steam conditions as follows:

1250 psig, 950 F— 950 F, 1.5 in. Hg abs
1450 psig, 1000 F—1000 F, 1.5 in. Hg abs
1800 psig, 1050 F—1050 F, 1.5 in. Hg abs
2400 psig, 1100 F—1100 F, 1.5 in. Hg abs

All heat rates were calculated from the following formula

$$HR = \frac{F(H_1 - H_F) + KF(H_R - H_E)}{kw} \quad \ldots\ldots [3]$$

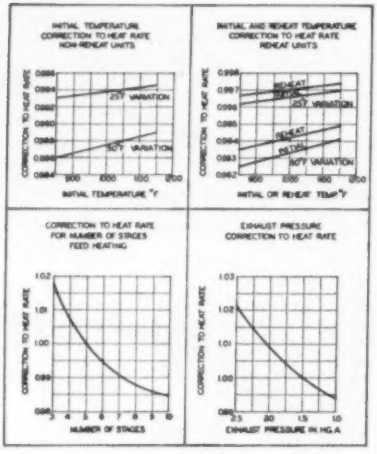
INITIAL TEMPERATURE CORRECTION TO HEAT RATE NON-REHEAT UNITS
INITIAL AND REHEAT TEMPERATURE CORRECTION TO HEAT RATE REHEAT UNITS
CORRECTION TO HEAT RATE FOR NUMBER OF STAGES FEED HEATING
EXHAUST PRESSURE CORRECTION TO HEAT RATE
CORRECTION TO HEAT RATE
INITIAL TEMPERATURE °F
INITIAL OR REHEAT TEMP °F
NUMBER OF STAGES
EXHAUST PRESSURE IN HG A

FIG. 13

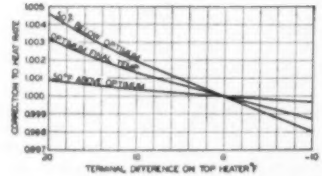

FIG. 14 CORRECTION TO HEAT RATE FOR TERMINAL DIFFERENCE ON TOP HEATER

The heat rates are based on five stages of feedwater heating as shown in Fig. 7. The arrangement and heater conditions are the same as outlined for the nonreheat units. The reheater pressure drop from the high-pressure element exhaust to the inlet of the interceptor valve was assumed to be 10 per cent. The final feedwater temperatures are the same as the nonreheat units and are tabulated in Table 3 for the same initial steam pressures. Flow margins are the same as nonreheat units.

Reheat Throttle-Flow Calculations. In a similar manner to the nonreheat units, the throttle flow at capability can be calculated from the following formula

$$F = \frac{HR \times kw}{(H_1 - H_F) + K(H_R - H_E)} \quad \ldots\ldots [4]$$

The heat added in the reheater $(H_R - H_E)$ is plotted in curve form in Fig. 16. The heat added is based on a reheat pressure which is 25 per cent of initial pressure.

After the throttle flow has been calculated, the reheater flow is equal to the reheater flow factor K times the throttle flow. The condenser flow is equal to 1 minus 0.93 times the extraction factor given in Fig. 10 or 11, times the throttle flow.

For example, assume a rating of 80,000 kw with a capability of 100,000 kw for steam conditions of 1450 psig 1000 F—1000 F, 1.5 in. Hg abs, five stages of feed heating, and a final feed temperature of 450 F. Using the heat rate at 100,000 kw from Fig. 10, the throttle flow is as follows

$$F = \frac{8180 \times 100{,}000}{(1491.1 - 430.1) + 0.91 \times 187.4} = 664{,}200 \text{ lb per hr}$$

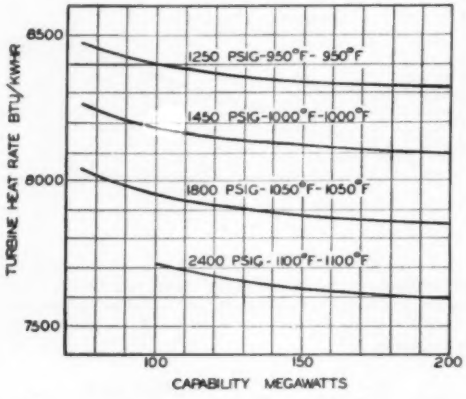

FIG. 15 TURBINE HEAT RATE VERSUS CAPABILITY LOAD FOR REHEAT TURBINE-GENERATOR UNITS
(Five stages feedwater heating exhaust pressure 1.5 in. Hg abs.)

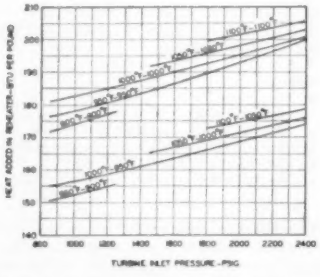

FIG. 16 HEAT ADDED IN REHEATER OF REHEAT TURBINE-GENERATOR UNITS
(Reheat pressures are 25 per cent of initial pressure.)

Reheater-Flow Calculations. The reheater flow is the K-factor times the throttle flow

$$R = 0.91 \times 664{,}200 = 604{,}400 \text{ lb per hr}$$

Reheat Condenser-Flow Calculations. The condenser flow is 1 minus 0.93 times the factor from Fig. 10, times the throttle flow

$C = (1 - 0.93 \times 0.308)\ 664{,}200 = 474{,}200$ lb per hr

Variations From Base Conditions. For steam conditions varying from the four basic ones in Fig. 15, use same correction factor explained under nonreheat units, except the initial-temperature correction factor which is shown in Fig. 13 for reheat units. The reheat-temperature correction factor is also shown in Fig. 13.

After the turbine heat rates have been corrected to the new steam conditions, throttle, reheater, and condenser flows can be calculated from Equation [4] as shown in the previous example.

CONCLUSIONS

This paper fulfills the needs of those interested in the generation of electrical energy, as it provides information to plan future economical power plants and to evaluate the status of power plants by providing the following information:

1 Heat-rate information of turbine-generator units operating on the regenerative heat cycle for capabilities of 75,000 to 200,000 kw for five basic steam conditions.

This together with previous publications covering turbine-generator units of 12,650 to 100,000 kw provides useful data for a wide range of kw ratings.

2 Heat-rate information at the turbine capability for kw sizes ranging from 75,000 to 200,000 kw, operating on the regenerative and reheat cycle.

3 Heat-rate data for turbine sizes and steam conditions which are considered practical combinations. Initial steam conditions are suggested, which, for average fuel costs and load factors, should result in economical installations.

4 Recommended temperature of the feedwater returning to the steam generator for the five basic steam conditions.

5 Means of calculating the steam flow required at turbine capability.

6 Method of calculating the steam flow to the condenser.

7 Method of calculating the steam flow and heat to be added for reheat turbine-generator units.

8 Information to show the optimum final feed temperature and the reduction in heat consumption for various stages of feedwater heating for steam conditions of 1450 psig 1000 F, and 1800 psig 1050 F.

9 Correction factors for variations from the basic conditions in stream pressure, temperature, vacuum, number of heaters, and final feed temperature.

ACKNOWLEDGMENTS

The authors wish to acknowledge the assistance and guidance of Mr. C. B. Campbell in the preparation of this paper, and for the assistance of Messrs. D. R. Cobb and J. H. Sturgis in the preparation of curves and other data.

Recent Developments in Francis Turbines

(Continued from page 196)

cis turbine design is the reversible turbine, which operates in one direction as a turbine to produce power and in the opposite direction as a pump to pump water, the hydraulic unit being connected to a single electrical unit which serves as both a motor and generator. This type of unit has found application in pumped-storage projects. Space does not permit a detailed description of the features of reversible turbines and pumped storage. However, it can be stated that model tests have shown very good efficiencies with the reversible turbine, both when operating as a turbine and as a pump.

A reversible turbine is now being manufactured for the Pedreira Plant, São Paulo, Brazil. As a turbine this unit is rated 18,720 hp at 89 ft head. As a pump it is rated 1800 cfs at 78 ft head, with a head range from 60 to 90 ft. The speed in both cases will be 150 rpm. Model tests on this unit showed 87.8 per cent when operating as a turbine and 89 per cent when operating as a pump.

In June, 1951, the Bureau of Reclamation placed an order for a reversible turbine for its Flat Iron Plant on the Colorado Big Thompson Project. As a turbine the unit is rated 11,000 hp at 300 ft head. As a pump it is rated 380 cfs at 240 ft head. The speed as a turbine will be 257 rpm and as a pump 300 rpm. This two-speed operation will be made possible by the use of a special-design alternating-current generator-motor. Extensive model tests will be made on this unit before the prototype is built.

CONCLUSION

The general trend in turbine design is toward reduction in over-all weight and cost by use of welded plate-steel construction, and by increasing the casing-inlet velocities. The increased use of stainless steels and aluminum bronzes to resist pitting corrosion and erosion results in a reduction of maintenance and costly outages. The use of these materials permits going to higher specific speeds for given heads with a resulting decrease in cost of the installation, and also permits the use of Francis turbines for high-head installations. Self-lubricating bearings and carbon seal rings indicate the desire of the designers to reduce field maintenance. The reversible turbine still requires some field operating experience but presents some interesting possibilities for pumped-storage projects.

ELECTRIC power load is expected to double its rate of growth during the next three years, but capacity will continue to climb to meet it, according to the *Industrial Bulletin* of Arthur D. Little, Inc., for January, 1952. For the past 20 years, the power load has grown at the rate of six per cent annually, but safety margins have increased as well. In 1951, there was an 11 per cent margin of capacity over peak load, but by 1955, with generating plants capable of carrying a load of 110 million kw and an expected peak demand of 96 million, the margin will be 14.5 per cent. Adequate reserves were predicted for most areas by 1953, but materials shortages are keeping expansion behind schedules, and defense needs have increased demand.

The United States is far in the lead in the amount of power generated, with 427 billion kwhr in 1951, or 43 per cent of the world's total. In 1920, the annual production was 530 kwhr per capita; today, it is 2800.

Use of electric power on farms has also grown rapidly, although it still accounts for only five per cent of the total amount consumed. In 1925, only four per cent of the nation's farms had electric service, compared with over 92 per cent today. Industrial uses are, of course, largely responsible for the growth of the power industry. Fifty years ago, the average industrial worker used one tenth of a kilowatt-hour of electric power for each hour he worked; the figure is now estimated at 6.5 kwhr.

Hydroelectric power accounts for only about 29 per cent of the electric power generated. Although hydro capacity is still growing rapidly, it is limited by the availability of suitable sites. TVA, for example, will nearly double its installed capacity during the next three years by the addition of five new steam plants. About 85 per cent of TVA's present output is from hydroelectric installations, but by 1954, steam will provide nearly half of the system's 6,813,000-kw capacity. These new steam plants represent over 10 per cent of the expansion in generating capacity planned over the next three years.

NEW PRODUCTION FACILITIES

A Brief Survey of the Machine-Tool Industry Today

By RALPH J. KRAUT

PRESIDENT AND GENERAL MANAGER, GIDDINGS & LEWIS MACHINE TOOL COMPANY, FOND DU LAC, WIS. MEMBER ASME

IN line with the theme "Strength Through Productivity" which the ASME Management Division adopted for its series of sessions at the 1951 Annual Meeting, it is my purpose to discuss briefly three aspects of the machine-tool industry:

1 Background and functions of the machine-tool industry in peace and war.
2 Status of America's machine-tool equipment.
3 The machine tool of yesterday, today, and tomorrow.

In dealing with machine tools, both of the two broad types encompassed in our National Machine Tool Builders' Association are included, namely, metal-cutting machinery, and metal-forming machinery.

BACKGROUND AND FUNCTIONS OF MACHINE-TOOL INDUSTRY IN PEACE AND WAR

The importance of the machine-tool industry must be measured by its considerable basic contribution to the American and world economies—not by its size. Our industry is a small one made up of approximately 300 companies, the largest with approximately 5000 employees, and the average with 200 to 250 employees. The average normal employment of the entire industry is approximately 50,000 persons, almost entirely highly skilled mechanics and engineers. The total investment represented by the companies in the industry just prior to Korea would total no more than $150,000,000. The average normal sales at present prices would approximate $400,000,000 annually, which is hardly one month's shipments for a well-known automotive company.

Despite this small size, the machine-tool industry is basic in our economy. Everything we wear, use, or eat, somewhere in the course of its production or distribution has the imprint of the machine tool. Machine tools are equally basic in all fields of productive enterprise—whether manufacturing, agriculture, mineral extraction, construction, transportation, or communication. Because machine tools make "interchangeable-parts manufacture" possible, the industry justifiably has been called the mother of mass production. Without machine tools our standard of living today would approximate that of 1850.

The real wealth of a nation is represented by what it produces, or, putting it in another way, the strength of a nation lies in its productive capacity—and productivity is certainly America's open secret. Machine tools add to output by increasing the workers' production, and the same machines that help speed the flow of products in peacetime are indispensable for the manufacture of weapons of defense. As Henry Ward Beecher said, "A tool is but the extension of a man's hand, and a machine is but a complex tool; and he that invents a machine augments the power of a man and the well-being of mankind."

The machine-tool industry has grown with the American economy despite the violent fluctuations in its economic history. Perhaps the brief summary in Table 1, showing the range of annual dollar shipments of the machine-tool industry (all approximately converted to present prices in order to give comparable physical volumes) will indicate quickly the wide variations in demand to which we are subject and the versatility and ingenuity we must show to swing with such sharp fluctuations.

TABLE 1 DOLLAR SHIPMENTS OF MACHINE-TOOL INDUSTRY

Years	Range of annual shipments in millions of dollars converted to present prices
1900–1914	60 (1908) to 130
1915–1920	200 to 400 (1918)
1921–1930	60 (1921) to 400 (1929)
1931–1939	80 (1932) to 500 (1939)
1940–1945	700 (1945) to 2500 (1942)
1946–1950	350 (1949) to 550

The tremendous increases in output during the two major war periods will be noted, especially in World War II, during which time the industry approximately doubled the number of machine tools in existence in the United States. In addition, normally our shipments include approximately 20 per cent of export.

Now we are well on the way to a third period of sudden and considerable expansion in output. The 1951 output for the industry at present prices should equal $750,000,000; 1952 should reach $1,500,000,000; and 1953 will possibly pass the 1942 peak of $2,500,000,000 at present prices. Dedicated to the arts of peace—the production of more goods for more people—our industry again, within a decade, is being called upon to do the fantastic job of tooling up a war economy superimposed on a peace economy—the so-called 40 per cent mobilization program.

Suffice to say that the machine-tool industry has the function in peace or war of "sparking" our economic growth. Without machine tools our economy would not have the steady 2 per cent annual increase in worker productivity that the economists consider to be normal.

STATUS OF AMERICA'S MACHINE-TOOL EQUIPMENT

It would be easy enough to describe in detail and to praise the greatly improved machine tools of today, but to me much more fundamental to the question of "Strength Through Productivity" would be for us to take a look at America's present machine-tool equipment or our inventory of metalworking equipment. Approximately every 5 years ever since 1925, the *American Machinist* has conducted and published an "Inventory of Metalworking Production Equipment." From this source Table 2 gives the total number of machines in place in the United States at each of the inventory periods (figures rounded off to nearest 50,000).

Next, let us look at the degree of obsolescence of the 1950 or pre-Korean inventory. Of the 1,762,165 metal-cutting machines shown in the 1950 inventory, 382,169 were 10 to 20 years old and 376,882 were over 20 years old. This means 43

Contributed by the Management Division and presented at the Annual Meeting, Atlantic City, N. J., November 25–30, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

TABLE 2 NUMBER OF MACHINE TOOLS IN UNITED STATES BY INVENTORY PERIODS

Inventory year	Metal-cutting machines	Metal-forming machines	Total machines
	—Number of machines installed, in thousands—		
1925	800	150	950
1930	1050	300	1350
1935	1000	300	1300
1940	950	300	1250
1945	1700	400	2100
1950	1750	500	2250

per cent obsolescence, because we consider a machine over 10 years old to be out of date, though not necessarily worn out—and 21 per cent extremely obsolete. For the metal-forming machines, of 471,257 units installed in 1950, 128,677 were 10 to 20 years old, and 131,455 were over 20 years old—55 per cent total obsolescence and 28 per cent extreme obsolescence. For both metal-cutting and metal-forming machines the degree of obsolescence representing machines over 10 years old is, therefore, approximately 46 per cent. To me this is a startling figure; and although a big improvement over the 1940 obsolescence figure of 72 per cent by reason of our large World War II production, it discloses a situation warranting earnest attention.

We believe that too often we have been the forgotten industry—only in time of war does the public or industry in general suddenly wake up to our basic situation—and then we are berated for not being able to produce the tremendous war requirements instantly. We have never asked for a subsidy, but the American machine-tool industry has not been nurtured by our economy as it might have been in consideration of our vital importance to both peacetime economics and wartime needs. By comparison, England and Germany, the other two principal machine-tool producers in the world, have always fostered and encouraged their machine-tool manufacturers.

Why do I say we have not been nurtured? First of all, in our principal peak periods, which unfortunately occur in wartime, our government does not recognize sufficiently that we are producing the same product, to be used in peace, in such tremendous quantities that we materially endanger our normal peacetime markets; and this same government taxes away, through so-called excess-profits taxes and renegotiation, all the normal profits we need to survive duller periods and continue research, development, and intensive sales and advertising programs. Then in times of peace the Government discourages the buying of more modern machines by industry with its obsolete and inadequate depreciation policies. The average machine tool carries an allowable tax-depreciation rate of approximately 5$^{2}/_{3}$ per cent, by Department of Internal Revenue rulings. Government considers the normal life of a machine to be approximately 18 years, which is neither true nor realistic. Add to this the problem of continuing long-time inflation, which makes a replacement machine tool even more costly. This gives some idea why managements and boards of directors are reluctant to buy an adequate quantity of new and more modern machine tools in normal peacetimes.

The foregoing makes for an unhealthy situation in the machine-tool industry, contributing to the violent fluctuations of demand. I personally believe that a more realistic policy of tax-depreciation rates would be the greatest single impetus to "Productivity Through Facilities" and not only would encourage continuously the purchase of modern machines by industry but also would flatten out the peaks and valleys of our shipments and would keep American industry in a continuing position of having the most modern equipment—certainly a real advantage for peace or war. Even the socialistic labor government of England after the war allowed 40 per cent depreciation when a machine was installed and 10 per cent to 12 per cent annual depreciation on the diminishing balance thereafter. Such a policy should be adopted by our own Government, and I trust that readers representing the managements of industries using machine tools will see the merit of this plan, the benefit to their companies and the American economy, and that they will urge their congressmen to take this most important step in the direction of "Strength Through Productivity."

In summing up the status of America's machine-tool equipment, I believe much more needs to be done in replacing completely obsolete machines with the modern present designs even before we give too much serious consideration to future anticipated improvements in machine tools.

THE MACHINE TOOL OF YESTERDAY, TODAY, AND TOMORROW

Because of the exacting standards which a machine tool must meet, the tendency in our industry has been for each company to specialize on one or at most a few types of machine tools and to develop them to a high degree. Further, it is unusual for any design of machine tool to remain standard for more than about 7 years; the development of a newer and better machine of that type making the old design obsolete in about that time. Actual surveys show that today's machine tools average better than 33$^{1}/_{3}$ per cent greater productivity than their predecessors. Thus a machine tool becomes obsolete long before it wears out. It becomes obsolete just as soon as there is another machine on the market which will produce more efficiently and at lower cost. Obsolescence reduces the economic life of a machine tool to a fraction of its physical life, although wear, aggravated by wartime multiple-shift operation, does show its effect by reducing accuracy. As shown by the *American Machinist* survey to which I have previously referred, many thousands of machine tools now on the floors of American factories could be replaced to the advantage of both owner and operator in the interest of more accurate work and greater economies in production.

Because there are more than 200 major types of machine tools and of each a number of sizes, it is difficult and needless to describe them all in detail. A few examples should suffice—taken from the six basic arts of shaping metal, namely, drilling and boring, milling, turning, planing and shaping, grinding, and shearing and pressing.

In the drilling and boring field the horizontal boring, drilling, and milling machine is probably the most changed and highly developed standard machine in this field. This type of machine developed originally from the engine lathe; hence, the left-hand head of some of the older designs. Up to 25 years ago it was strictly a boring machine, and at the time there were few machines installed of larger than 3-in. or 4-in. spindle diameter, with most of them of the so-called "table type." Power rarely exceeded 10 hp, and belt drive through line shaft was used. Spindle speeds hardly reached 400 rpm. Weights in excess of 20,000 lb were unusual. Way surfaces were exposed soft cast iron, subject to scoring and wear. Gears, shafts, and other parts were made of then existing conventional metals with inadequate hardness and accuracy rarely exceeding 0.001 in. Machine controls were manual, complicated, and cumbersome. Measuring at best was by scales and verniers. Few accessories and attachments were available.

Today by comparison we have the modern right-hand machine which has developed into a versatile open-end type of machine doing a host of milling, boring, drilling, and related operations—studies showing that these machines are now used 60 per cent for milling. The sizes and types have increased tremendously, with 2$^{1}/_{2}$ to 10-in. spindle diameter in table, floor, planer-type, and multiple-head types. Power now ex-

ceeds 100 hp, and spindle speeds run above 2000 rpm. Weights reach 300,000 lb. Hardened ways are now in common use, and gears, shafts, and parts make use of the great technological developments in raw materials, heat-treating, and accuracies as close as 0.0001 in. Most important, machine controls using electronic and hydraulic as well as mechanical means have improved vastly machine operation. Measuring and automatic positioning today employ not only mechanical but also optical hydraulic and electronic means to gain settings of 0.0001 in., which, of course, involves a much greater all-round accuracy in the machine. Furthermore, the application of hydraulic and electrical duplicating equipment has made possible the usage of horizontal boring, drilling, and milling machines in so-called die-sinking and contouring operations, particularly on unusually large parts. A host of accessories and attachments are now available to make this type of machine more versatile—revolving tables, continuous-feed facing heads, special milling heads, underarm attachments, and the like. Every decade or less has shown marked improvements in the design and performance of horizontal boring, drilling, and milling machines. Incidentally, referring to the *American Machinist* survey, of 17,784 machines of this type in place, 4410 were from 10 to 20 years old and 4034 were over 20 years old—an obsolescence of 47 per cent.

Vertical boring and turning mills, which actually are a part of both the drilling and boring and turning fields and which include vertical turret lathes, have shown similar startling developments. The impact of carbide-tool development has caused a substantial increase in cutting-speed rates, with the resultant increase in horsepower requirements. Ten years ago 40 to 50 hp was considered maximum on most vertical boring mills; today 100 hp is not unusual to meet modern cutting requirements. The use of adjustable-speed d-c motors with electronic controls has reduced the number of gear changes and makes possible a wide range of speed control. Multiple motor drives in place of direct mechanical connection to main power source again increase the flexibility of these machines. Also, increased use of automatic controls to remove the human element shows promise of increased production from less skilled operators on these machines. Examples of this would be the vertical turret lathe with automatic set-up devices for repetitive manufacture, and the automatic vertical boring mill with four cutting heads including contouring devices on two heads for machining railway-car wheels. Another means of increasing production of vertical boring mills is the use of electronic controls to maintain constant cutting speed of the work relative to the tool as the tool proceeds from large to small diameters on facing cuts on these machines. Using this device the operator no longer is required to stop the machine, shift gears, and restart the machine to maintain an optimum cutting rate. The machine automatically does this job for him. Referring again to the *American Machinist* survey, of the 19,590 vertical boring mills and vertical turret lathes in place in 1950, 4105 were from 10 to 20 years old and 6459 were more than 20 years old—an obsolescence of 54 per cent.

In the planing and shaping fields, a power revolution has taken place within the past 15 years. Consider the metal-cutting planer of 20 years ago—a light machine equipped with a driving motor varying in horsepower from about 5 to 20, powering the reciprocating table through flat leather belts of limited power-transmission ability. Amid much screeching of belts as they were transferred between reversing pulleys, metal parts were machined in limited amounts. As late as 1935, the direct-drive planer came into considerable favor utilizing an adjustable-speed direct-current electrically reversible motor, eliminating the need for power transmission by belting. Planing speeds were somewhat increased over those used with belt drives, up to approximately 150 fpm, but the significant development was an increase in power available, enabling planers to take heavier cuts. This era was marked by the use of d-c motors, this form of power being available in most shops at that time. About 5 years before World War II, however, the output of planers was tremendously increased by the more widespread use of tungsten-carbide tooling which permitted increased cutting speeds, thus again requiring greater horsepowers. These requirements for higher cutting speeds of at least 300 fpm presented the electrical industry with a problem of obtaining wider speed ranges than were available by the use of an adjustable speed d-c motor on a constant-voltage power supply. The solution to this was the adjustable-voltage drive, known in Europe as the Ward-Leonard drive. The use of this type of drive was considerably encouraged by the prevalent use of alternating current and the gradual extinction of the direct-current power system in our country. Greater accelerating rates, in order to cut down reversal time, called for greater horsepowers, so that use of motors ranging up to 100 hp was not uncommon. It must be understood that these equipments were powered by adjustable-voltage motor generator sets which were, in turn, driven by a-c motors ranging up to 300 hp. Future improvements in tooling, requiring heavier machines, inevitably will lead to still more powerful drives on this type of machine. Again referring to the *American Machinist* survey, of 16,570 planers installed in 1950, 3286 were from 10 to 20 years old, and 9163 were over 20 years old—an obsolescence of 75 per cent. Some of this obsolescence, of course, is due to the increased use of milling. However, with the horsepowers and cutting speeds today available in planers, as well as the use of carbides and multiple tooling, a very considerable usage of this type of equipment will continue in the future.

The evolution of the planer-type milling machine, which is a part of the milling field, is one of the most striking developments in the machine-tool industry. The multiple-head planer miller of yesterday was equipped with a single motor which was mechanically connected to the four heads through shafts and belting. A motor of about 40 to 50 hp was used, the horsepower which each head might develop depending on how many heads were in operation at a given time. The machine of today has individually motorized heads, each of which may be equipped with various-sized motors up to 75 hp. On this basis, 300 hp may be developed at the cutting heads for removing metal. Many additional features especially as to controls also have been added to planer millers as well as some of the types of developments described previously.

A most recent evolution of the planer miller is the airplane-wing skin miller. For use on modern high-speed planes, an airplane skin is now required in which the ribs are an integral part of the original skin, in place of the riveted and fabricated structure used in the past. At the present time the only method of making these skins on a production basis is by milling them out of a solid slab of aluminum. Very high spindle speeds and horsepowers are required for this process, including also duplicating and contouring devices for machining tapers and contours in wing sections and components. This ultramodern Goliath costs more than a half-million dollars, weighs approximately 500,000 lb, and requires 450 hp. Referring to the *American Machinist* survey, of 4114 planer-type milling machines installed in 1950, 1029 are from 10 to 20 years old and 1437 are more than 20 years old—an obsolescence of 60 per cent.

There are equally impressive improvements in the many other types of machine tools such as thread grinders, centerless grinders, broaching machines, hobbers, contour and automatic lathes, and the like.

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How to Make the Best Use of CONSULTING ENGINEERS

By H. WARREN ROOS

SENIOR STAFF MEMBER WALLACE CLARK & COMPANY, INC., NEW YORK, N. Y. MEMBER ASME

INDUSTRIAL concerns frequently decide they have a problem, engage a consultant, dump the problem in his lap, and proceed to forget about the entire project. Recently, a prospective client, after reading a trade-magazine article on "quality control," decided that it would be a cure-all for his problems and called us in to discuss the matter. In effect he said, "Quality control is good stuff—we need some of that," in the same sense that one might take a patent medicine to cure everything from a broken leg to a headache.

Unfortunately, management techniques are not such cure-alls, and management consultants can work miracles only through hard work and the full co-operation of the client organization.

In order for the consultant to get the help needed to solve a problem, and for the client to make the best use of the consultant's services, the client must exert concentrated effort (1) to detect the problem, (2) define the problem, and (3) select the consultant.

After the consultant is selected the client must continue his efforts in co-operation throughout to prepare for the consultant's program, assist by full collaboration during the project, and follow up to insure that benefits are permanent.

Let us examine these various stages of co-operation to determine their importance in carrying out a successful program of collaboration:

IS THERE A PROBLEM?

If there is a problem it will make itself apparent in one or both of two ways as follows:

(*a*) The company cannot meet delivery promises.
(*b*) The company cannot meet competitive prices.

If this is the case, management is in trouble either with the customers or with the directors. Therefore the responsible executive must determine what the problem is.

On the face of it, it might seem that defining the problem would be a relatively simple matter. Frequently, however, it is not. If a company cannot meet delivery promises, production obviously must be increased. But is the best solution to be found in expansion of facilities, in redesign of the product for mass production, in different manufacturing methods, or in improved production and stores-control methods?

If competitive prices cannot be met, it would seem to indicate that the competitors have discovered a way to produce more salable goods with the same amount of labor and material. Perhaps better management controls are the answer—quality control, production planning, stores-keeping, and so forth.

Better quality control will reduce the cost of scrap, thus decreasing the cost per salable unit.

Improved production planning and stores control will reduce the production-cycle time, thus decreasing the investment in inventory and the resulting overhead charges for interest, floor space, heat, light, and so forth.

Production methods improvements will reduce both direct labor and material costs, with accompanying decreases in overhead.

In order to define the problem, therefore, it is necessary for management to scrutinize all phases of the operation and to use every test available to determine the sources of the problem. Having located the source, it then becomes possible to define the problem and to consider steps to be taken to eliminate it.

SELECT THE CONSULTANT THAT CAN BEST SOLVE THE PROBLEM

The choice of the most suitable consultant for a particular problem in a given industry is a difficult one. Several good sources for compiling a list of prospective consultants are available: Association of Consulting Management Engineers, The American Society of Mechanical Engineers, business associates, and banks, are all good sources. Having presented the problem to the prospective consultants, each should be requested to outline his proposed program for solving the problem. Most reputable consultants will devote sufficient time to the preliminary analysis of a problem to develop a program for the solution, will submit this program in the form of a proposal, and will quote an estimated cost for carrying it out.

The consultant's program may not always agree with management's ideas. For example, in one case known to the author, a manufacturer of electrical appliances felt that the solution to his problem was an overhead trolley conveyer that would provide both transportation and storage of partially completed assemblies that were cluttering up the various departments. Further analysis revealed that, although the conveyer would help, the real source of difficulty was inadequate production and stores control methods. The partially completed assemblies were cluttering up the place simply because parts were not on hand to complete them. The condition had existed for so long that management had become accustomed to it and did not recognize the source of the difficulty. An outsider, coming in to analyze the situation, found the real problem and suggested a program for eliminating it at the source. By making all parts available when they were needed it would be possible to reduce in-process inventories and keep production moving.

Sometimes management feels that unless a consultant has had recent experience in the particular field to be examined, he cannot be of much help. On the other hand, occasionally the opposite attitude is encountered—management wants a completely different viewpoint so insists upon finding a consultant who has not had assignments in his industry. In our experience, sound engineering and management principles apply equally to all fields and a qualified consultant can carry out a program for improvement regardless of whether he has or has not had recent experience in the specific industry in question.

Presented at a meeting of the Metropolitan Section, New York, N. Y., October 11, 1951, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

An example of the latter attitude, where management wanted a completely different viewpoint, was the case of an airline that approached us some 5 years ago to develop plant layouts for its new overhaul base. The line was expanding, going from what was in effect a job-shop operation to a semiproduction operation, and wanted new ideas; that is, ideas new to the air-transport industry. Management felt that the industry had grown to the point where benefit could be derived from methods and techniques which other industries had found to be valuable management tools.

After successfully completing this assignment, we were then approached by other airlines whose management represented the more prevalent attitude. Because we had experience in their industry, they felt that we could help them, whereas they would not have considered our services prior to our air-line engagement.

Our experience indicates, therefore, that it is not important to search for a consultant having experience in a specific industry. It is of the utmost importance to find one whose approach meets the problem in such a way that the problem can be solved.

Having discussed the problem with various consultants, and received their recommendations for the solution, and their estimates of cost, it is relatively easy to narrow down the field. Before reaching a final decision a more thorough investigation should be made to determine whether the engineers who will be assigned to the project will be acceptable to the client organization as a whole. As much care should be taken at this point as one would take in adding a new member to his executive staff. It may not be practical to conduct personal interviews with all of the consultant's staff members, because of time and distance involved, so that careful investigation of references is in order.

PREPARATIONS FOR THE CONSULTANT'S PROGRAM

The mechanics of providing suitable working space, equipment, and services (typing, clerical, telephone, and the like) are easy enough. Preparation of the client organization is another matter, and of more importance, if best results are to be obtained from the collaboration. During the preliminary conversations the consultant will have talked to key personnel and will have discussed the problem to such an extent that they will know in a general way what the program is to be.

Management should follow up its selection of the consultant with a statement outlining exactly what the program is, who the consultant is, and emphasize the point that he is being brought in to help the organization to increase its effectiveness, not to criticize personnel, practices, or existing methods and procedures. The full co-operation of all levels of the organization must be enlisted by stressing the point that it is assumed every employee wants to do a fair day's work for a fair day's pay, and that the consultant is being brought in to remove obstacles which have prevented either one or both of these aims in the past. No reputable consultant will accept an assignment the purpose of which is to "sweat" more work out of men. It is surprising how frequently this fear is encountered among shop personnel. The sooner it is dispelled, the less time there is available for rumors to start snowballing into a real problem.

Also at this time the inside collaborators, or "understudies", as they are frequently termed, should be appointed and arrangements made to free them of their routine duties so that they can devote full time to the consultant's program.

Early in the project, certainly during the first week of collaboration, management should review existing conditions with the consultant. Unusual organization structure, personalities, or other conditions peculiar to the situation, should be brought out and discussed with the consultant. A plan for handling these secondary problems during the period of collaboration should be worked out.

We experienced such a situation shortly after the war in the plant of a manufacturer of specialized machinery. The Repair Parts Department was staffed with elderly men who previously had been mechanics but who, because of illness or injury, or in some cases old age, reached the point at which they could no longer work as mechanics. Several were past retirement age, but were staying on out of their loyalty to the company merely to help during the critical period. However, these men had acquired a thorough knowledge of the company's products through their years of experience in the shops, and this knowledge was of great value in identifying repair parts from a verbal description or perhaps a rough sketch. On occasion, they could go back 30 or 35 years in their memories and identify parts needed by a customer who had long since lost the drawings and specifications for his particular machine.

As former mechanics, this group had little use for paper-work routine, with the result that they handled repair parts in their own special way. As a matter of fact, there was no mechanism by which the Production Control Department could be notified of the volume or shop backlog represented by "repair orders." The old timers would receive an order, go and find the needed materials, have them machined and arrange for shipment, almost entirely by oral instructions. Processing time was excessive, and the repair-parts backlog was building up to the point at which customers were complaining bitterly about service.

Being forewarned of this situation, we were able to set up a simple procedure which made it possible to take advantage of the knowledge that these men had, and at the same time get sufficient control of the repair orders to permit production control to reserve time to handle orders along with regular manufacturing lots. A few words of advice from management enabled us to retain the good features of the Repair Parts Department, while at the same time overcoming the obstacles that were seriously affecting customer relations as well as company profits.

The next preparatory step should be to meet with all key personnel and have the consultant explain the manner in which he plans to carry out his assignment. The representative of top management who has been instrumental in bringing in the consultant should preside at this meeting to emphasize his backing and approval of the program.

COLLABORATION DURING THE INSTALLATION PERIOD

In order to maintain continued interest in the program among those working on it, as well as to keep the consultant on the beam, management should request written progress reports at regular intervals throughout the period. Depending upon the nature of the assignment, these reports should be at from one-month to three-month intervals.

Report meetings should be held in the executive conference room, and all parties concerned in the subject matter of the report should be invited. This means department heads, foremen, group leaders, any person having a key position in the project, and in all cases the understudies. The reports not only should state progress, but also raise questions upon which guidance and decisions are asked from management. In order not to delay the program, and thus increase the cost, management must then take prompt action in providing the answers and the decisions requested.

During the latter part of an installation, most consultants will set up a series of simple "executive reports" that will be

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What the Engineering College Will and Will Not Do for the Student[1]

By H. P. HAMMOND

DEAN EMERITUS OF ENGINEERING, THE PENNSYLVANIA STATE COLLEGE

IN THE first place, the college will make it possible for you to obtain a pretty sound education on which to base your future career, not as broad or as sound as it might be under impossibly ideal conditions, but, nevertheless, a good education by any reasonable standards.

The college is aiding you to develop a strong quality of honesty and reliability. This is in large measure because you were that kind of a young man to begin with, otherwise it is not likely that you would enter engineering. It is also growing naturally because of the nature of your studies. Science and engineering rest on immutable laws of nature, and their application must be carried out honestly. No amount of argument can change the solution of an engineering problem. This fact is leading you to develop an objective view toward your work and to avoid any tendency to fool either yourself or others. This is the most valuable result of all those that will grow out of your college career, and you should have a just sense of its value in developing your character.

Your college is developing in you a sense of loyalty not only to the college itself but to your profession and to the nation at large. This is another great contribution to your development.

Your college career will help you to become industrious. You will learn to work hard and purposefully, an indispensable qualification in the world of competition in which you will earn your living.

You have begun to learn, though imperfectly, that you cannot take things for granted or jump at conclusions. You are beginning to learn that the situations with which you deal will have to be examined carefully and analyzed critically. You may not realize that this quality is forming in you, but it is. I am sorry to say, however, that it does not develop as fully as it should in some engineers; that is why some are more successful than others.

You are acquiring the basis of earning a good living and there will be plenty of opportunities for you to do so. Few of you will become rich but with comparatively few exceptions you will be able to live comfortably by any reasonable standard. For example, you will be able to have your children go to college, as you have gone, but it will be at sacrifices on the part of your family. I think you need not regret that, on the average, you will merely earn a comfortable living instead of an affluent one. It is that kind of people who comprise the backbone of this country. Expressed in today's terms, yours will be a one-car family, but I venture to say that in comparison with many of the rich it will be a happy one. This will be so, among other reasons, because your life will be lived in a sense of doing something useful for the rest of the world.

Your college constitutes a wholesome community. The world has not seen, up to now, anything better as a place in which to form your associations and to work than the typical American college. Whether you realize it or not, this is having a wholesome influence on you as an individual and as a citizen.

These four years will bring you to the threshold of maturity (some of you have already crossed it) pretty well equipped both as an individual and as a future professional man to enter upon your responsibilities. This is something to which you probably have not given much thought. You need scarcely be reminded that you will have very important assets with which to begin your career.

All of these things and others that I could recite are what your college is helping you to do and to become. They make an impressive total that ought to give each of you a sense of gratitude and obligation to your college and the public that supports it. You can fulfill that obligation by making the most of your opportunities.

Now let us turn to some of the things your college is *not* doing for you. Here, I repeat, I am considering engineering colleges collectively. They differ over a considerable range in relation to the specific points mentioned.

For one thing, you are not acquiring habits of thoroughness or of strict accuracy to the extent that you should. You are not learning to check your work, to size it up by looking it over, or to run over your computations to see whether your results are reasonable. You will *have* to learn to do this and learn it promptly after graduation. One just cannot make mistakes when safety or dollars are involved. There is no such thing as a 60 per cent passing grade in practice. You would be wise to start the habit of accuracy now.

You are not being trained to subject your work to a general appraisal of its suitability or the worth-whileness of the project or design on which you are working. As mature engineers this quality of judgment is one you must develop if you are to occupy positions of responsibility.

You are developing very little appreciation of the financial or economic phases of what you do. The extent to which you will be able to handle financial and economic problems will be another factor determining the level to which you will rise as an engineer.

Your sense of the aesthetic qualities of a product is scarcely being developed at all, in fact, a good many of you may not recognize the necessity of this quality, to say nothing of consciously endeavoring to nurture it. Yet in practice, industrial concerns are well aware of the necessity of good harmonious appearance whether it be of a bridge, or an internal-combustion engine, or even such a small thing as an electric-light switch.

You are not acquiring sufficient knowledge of the exceedingly important part that the properties of materials play in industry. This you can remedy in part and you should set about promptly to grasp every opportunity, of which there are a great many, to store up knowledge about materials and how to use them.

Few of you are acquiring appreciable knowledge of the engineering of production processes. It is on these processes that American world leadership in industry largely rests. As one aspect of this, your courses in design, by and large, are not

[1] Th.s article is based upon a similar article by the author which appeared in the "Penn State Engineer" for October, 1949. The word "college" is used in a collective sense throughout the article.

training you to design products with respect to the manner in which they are to be manufactured.

Many of you have the mistaken idea that your future engineering work is likely to be closely along the lines of your curriculum. I can assure you that this is not likely to be the case. Your curriculum will provide the basis on which you can build your career in a considerable variety of fields and your graduating class is bound to scatter into a wide range of occupations, many of which you little suspect you will enter. Look broadly, therefore, on your courses of study and put just as much emphasis on courses taught outside of your department as you do on those taught in it.

We, the faculty, are not giving you as wide an understanding as we should of your responsibilities and opportunities as professional men and citizens. It is too bad that this is the case, and I wish we might do more about it. You will have to acquire knowledge and appreciation in these matters if you are to discharge the obligations that your education imposes, and I hope you will begin to do so soon after graduation.

We, again speaking collectively, are doing very little to help you to develop your initiative and originality. There are two chief reasons for this: (1) Your work is laid out for you very closely. Virtually everything you do from day to day and from examination to examination is specifically assigned. Your nose is held so close to the grindstone of daily assignments that you have too little time to think for yourselves. (2) In the laboratory where there are opportunities to place responsibility upon you in laying out experiments, assembling equipment, and leading a squad, the work is likely to be laid out in meticulously detailed instruction sheets, ruled forms, and specifications for your reports. Efforts are now being made in quite a number of colleges to change the prevailing system by giving more opportunities for the exercise of responsibility and even for the development of initiative and originality. But so far, in the main, our failure to aid you in developing these qualities remains unchanged.

We train you too much to approach the use of a given principle in terms of derived formulas instead of in terms of the simple statements of physical laws in their basic forms. Thereby you are not acquiring as you should the ability to apply principles to new and unfamiliar situations which is one of the cornerstones of advanced practice and pioneering.

When you are graduated your education will not be finished. On the contrary, if you are to go far as professional men you will have to continue your education through many later years. Engineering and science are changing so rapidly that no college curriculum could possibly keep pace with them; that must be left to the years after graduation. The college can only help you to lay the foundations on which to build.

New Production Facilities

(*Continued from page 216*)

Turning now to the metal-forming field, present-day machines are the giant successors to the blacksmith; and include the mechanical or hydraulic press used to blank out the desired shape from a metal sheet and to squeeze it into the desired shape in a die under tremendous pressure; the shear used to cut metal into shape; the press brake used to bend strips or sheets; the drop hammer, operated by steam or air, used to forge or hammer red-hot metal on an anvil; the forging machine in which a piece of red-hot metal is squeezed in a die under great pressure so that it flows into every part of the die and assumes the desired shape; and the punch press, a small press used to punch holes in metal sheets. Indicative of the developments in this field would be the 75,000-ton press now being built for the aircraft industry. Compare this with the 700-ton presses used at present for automobile tops.

Aside from standard-type machines there has been an increasing usage of single-purpose machines in the American economy, especially in mass-production plants, such as in the automotive industry. Transfer-type machines, actually combining many individual machine tools into a unit, perform numerous operations with minimum labor. For example, one special-purpose machine tool automatically completes 45 operations on an airplane supercharger in 24 minutes. This part formerly required 8 machines and 4 hours to produce. Nevertheless, the evolutions and improvements on standard machines, engineering-wise, apply equally to special machines.

CONCLUSION

Emphasis should be given of the importance of this country nurturing its machine-tool industry by practicing the sounder tax and depreciation policies which have been suggested. If this is not done, economics will drive many builders into other fields, as has been demonstrated already by various machine-tool builders in the past postwar period entering such fields as textile machinery, plastics machinery, road-grading equipment, and the like. The loss of 30 to 40 companies (almost 10 per cent of our corporate units) in the post World War II period by liquidation, consolidation, and the like, should not be permitted to continue after the present defense or war program ends. America needs a strong machine-tool industry, and I am certain she shall have it.

If so, we can rest assured that while the developments of today, projected on the screen of the machine-tool picture of World War II, challenge the imagination, future developments will likewise overshadow our machine tools of today.

How to Make the Best Use of Consulting Engineers

(*Continued from page 216*)

submitted at regular intervals to indicate the performance being achieved by use of the new techniques. If the consultant does not do this of his own accord, management should insist upon it.

Such reports serve two purposes. Since they originate in the department responsible for performance, that department will put extra effort into its operations to insure that the report is a good one. The reports also serve management in that they will indicate conditions where executive action is needed to remove obstacles beyond the control of the Operating Departments.

Even with an effective series of executive reports, arrangements should be made with the consultant to make a series of follow-up visits over an extended period. Such visits might be for only two or three days every three to six months, or they might need to be as frequent as one week each month. The length and frequency of such visits depend entirely upon how well the organization had mastered the new technics.

CONCLUSION

It should be emphasized that to bring in a consultant to "fix things up" without a real appreciation of what needs fixing is not the way to get the best value from his services.

The full co-operation of all levels of management, beginning with the determination of the problem, selection of the consultant, preparation, collaboration, and follow-up, is absolutely essential.

Only by such co-operation and active participation throughout can management and the consultant expect the best results.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

J. J. Jaklitsch, Jr., *Technical Editor*

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Engineering-College Enrollment

THE dangerous gap between the supply of engineers and the need for their services is becoming wider, according to a report made by the U. S. Office of Education and issued jointly by that office and the American Society for Engineering Education.

Only 28,000 engineering students will graduate in 1952 to meet the current demand of from 60,000 to 90,000 engineers. There were 38,000 engineering graduates in 1951; consequently the supply of engineers this year will be 10,000 fewer, a reduction of more than 25 per cent. Since many of the 1952 graduates are either members of ROTC units or are subject to the draft, having been granted deferments to complete their college courses, defense industry is likely to find itself with a deficit of from 40,000 to 70,000 engineers, the report states.

The graduation of the last large group of veteran students has dropped the total engineering enrollment 8.4 per cent below that of last year. This decrease, however, compares favorably with the decrease in male student population reported by all higher educational institutions, which is almost 11 per cent smaller than in the fall of 1950.

According to the report, 147,694 engineering students were enrolled in the fall of 1951 in the schools accredited by the Engineers' Council for Professional Development. Undergraduate students numbered 128,367, while 16,452 were studying for the master's degree, and 2875 students were studying for the doctor's degree.

A checking of the decline in engineering enrollment is indicated by an increase in the number of freshmen engineering students of 16.2 per cent over 1950. Industry will not, however, have a chance to benefit by this increase until four years hence when it will find that it has heavy competition from the armed services, since an increasing number of freshmen are joining ROTC units.

The increasing desire for graduate training in engineering is reflected by the fact that graduate enrollment is now three times what it was in 1940. At that time the graduate students comprised only 4.6 per cent of all engineering students. This fall, 13.1 per cent of all engineering students were taking graduate work. For the entire college population, the percentage of graduate students is estimated at about 10 per cent. Almost 28 per cent of all engineering graduate students are taking their training in electrical engineering. Mechanical engineering accounts for about 17 per cent, while approximately 13 per cent are enrolled in chemical engineering.

The distribution of bachelor's degrees granted in 1951 among the four principal undergraduate engineering curriculums was as follows: Mechanical engineering, 9609; electrical engineering, 8616; civil, 6473; and chemical, 3614. The number of graduates in each of the four curriculums was considerably lower than the previous year. In mechanical engineering, 26.4 per cent fewer graduated. About 30 per cent fewer were graduated in electrical engineering, 11.5 per cent fewer in civil, and 18.3 per cent fewer in chemical.

Undergraduate enrollment in the four principal curriculums of ECPD accredited schools in the U. S. was as follows: Mechanical engineering, 27,080; electrical engineering, 24,515; civil engineering, 19,701; chemical engineering, 11,533.

The data contained in this report are based upon a survey of engineering schools and colleges made in October, 1951, under the joint sponsorship of the U. S. Office of Education and the American Society for Engineering Education. In accordance with an agreement reached by the joint committee of the Office of Education and the ASEE, all institutions listed in the Office of Education Directory of Higher Education which reported that they conferred degrees in engineering during 1950–1951 were requested to supply data. Eight Canadian institutions were also included. Replies were received from all institutions accredited by the Engineers Council for Professional Development, from 44 other U. S. institutions, and from 7 in Canada.

Economic Situation

THE volume of national output increased by about 8 per cent in 1951 as compared with 1950, and was higher than that of any other year, according to a year-end review of the economic situation by Secretary of Commerce Charles Sawyer, in the Jan. 8, 1952, "Bulletin of Commerce." This large ex-

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.

pansion in production permitted the nation to push ahead toward its objective of increased military strength, while at the same time broadening productive capacity. The needs of consumers were also met on as high a scale as in the preceding year—a period of high consumption.

During the course of the year the pace of advance in output slackened, and in the final quarter the total volume of national output was about 5 per cent above the rate in the fourth quarter of 1950.

The value of output of final goods and services—the gross national product—totaled $327 billion, 15 per cent more than in 1950. Roughly, half of this rise represented higher prices, and the remainder the increase in volume. This expansion in the volume of output was attained by increased utilization of the nation's manpower, by expanding facilities, and by the more intensive use of existing capacity.

In 1951, as the United States mobilized its resources for defense, expenditures for military and related purposes were $34 billion—more than double the 1950 total. Along with this large increase, the flow of civilian products was maintained in volume, but cost consumers 6 per cent more than in 1950 because of higher prices. Most of the price advance occurred prior to the inauguration of price and wage controls in January, but many prices moved up subsequently. The nation also made available a larger volume of goods and services to strengthen the economics of foreign nations.

Industrial production was 10 per cent higher in 1951 than in 1950. Although there were important shifts in the composition of output during the course of the year, there was little variation in the total. Almost all types of civilian goods were produced at record or near-record rates in the first quarter of the year. Beginning in the second quarter, there was a progressive curtailment in most types of consumer durable goods—notably automobiles and major appliances. Production of some nondurables, particularly textiles, was also cut. This was offset by expansion of producers' capital equipment and defense goods.

Although the inflationary pressures—a major concern at the beginning of 1951—had eased off as the year progressed, the economy at year-end was faced with many basic problems. Chief of these were the following: (1) To build up our military strength as rapidly as possible while maintaining a strong civilian economy, and to utilize both large and small business in securing needed production; (2) to conserve and channel our available scarce resources most equitably and efficiently so as to meet our defense objectives and yet, to the extent consistent with our military needs, to minimize the adverse effects upon the civilian economy, and particularly to small business; (3) to prevent or to contain any resurgence of inflationary pressures either through the impact of higher costs of doing business or of new waves of demand; and (4) to obtain an approximate balance in the defense period ahead between government expenditures and income so that our defense effort may be paid out of current receipts in so far as possible.

Power

DURING 1951, some 370 billion kwhr were generated by the electric power industry plus an estimated 60 billion produced by private industrial power plants for their own use, according to a survey appearing in *Combustion*, January, 1951. The peak utility demand reached nearly 70 million kw whereas the total central-station capability at the end of 1951 was around 78 million kw. Reserve margins were very small in some sections, notably the Pacific Northwest and some sections of the Southwest.

Approximately 7½ million kw of central-station capacity were added during the year, a figure which would have been greater had not lack of materials cut into scheduled deliveries. This applied not only to major units, but to auxiliary equipment as well. Additions scheduled for 1952 exceed 10 million kw although, here again, the continuing materials situation is likely to necessitate further rescheduling with a consequent reduction in gross reserve margins well under the figure previously anticipated for 1952.

Steam capacity of more than 25 million kw and hydro capacity of around 5½ million kw are now on order for delivery before the end of 1953, the largest percentage increase being in the south central region of the country.

In the industrial power-plant field the greatest activity in the way of increased installed capacity is in basic lines such as steel, copper, aluminum, oil, and the like, where there is a marked trend toward units of larger size. Over 1½ million kw capacity is said to be on order for such plants.

DEFENSE PROJECTS

To meet specific defense requirements for large blocks of power several projects were undertaken. Notable among these was the organization of Electric Energy, Inc., by five utility companies to build and operate a power station of 652,000 kw initial capability near Joppa, Ill. This will contain four reheat units operating at 1925 psi, 1055 F, and supply half the power requirements of a huge atomic-energy plant, the other half of which will be supplied with power by TVA. The latter now has 1,800,000 kw on order for installation in three new steam power stations besides having recently placed in service the first units of its new 750,000-kw Johnsonville steam plant.

A most unusual defense installation is that of Henry Kaiser's new aluminum plant in Louisiana containing eighty 1820-hp gas engines of the radial type running on natural gas.

LARGE UNITS PREDOMINATE

Realization that large units mean lower investment costs per kilowatt, as well as lower operating costs, is responsible for the adoption of a number of units of 150,000 and 200,000 kw in some of the new plants now under construction.

The arrangement of one steam-generating unit per turbine has become general practice in most of the new installations, as well as widespread adoption of the reheat cycle which has justified itself through increased thermal efficiency and simplicity of operation for units of 60,000 kw and over.

Steam conditions for the very large units installed and ordered during 1951 range from 1670 to 2650 psi with 1000/1000 to 1100 F temperature, whereas at least a fifth of the total capacity installed last year was for pressures in excess of 1450 psi. The highest initial temperature of 1100 F will be employed for two 145,000-kw controlled-circulation units now under construction for the Kearney Station of the Public Service Electric and Gas Company of New Jersey.

New low-alloy ferritic steels containing chromium, molybdenum, and vanadium have shown excellent strength at 1050 F and are being widely used for casings, piping, and valves at this temperature in place of high-alloy stainless steels.

During the last 15 months, 19 large high-pressure controlled-circulation steam-generating units have been ordered by nine well-known utilities. These range in steam output from 750,000 to 1,450,000 lb per hr and represent an aggregate capacity of 2,615,000 kw. The highest pressure is 2650 psi.

In the turbine field the trend in large units has been toward the tandem-compound 3600-rpm type, with single-shaft machines up to 200,000 kw on order. Several tandem-compound double-flow 3600-rpm units put out by one manufacturer incorporate a design that confines all the high-temperature steam to the same region of a single high-pressure casing.

The first tandem-compound triple-flow 3600-rpm reheat unit of 121,000 kw capability and designed for 1800 psig, 1000/1000 F, was delivered during the year to the Waukegan Station of the Public Service Company of Northern Illinois. It has two high-pressure casings, one before and one after the point at which the steam is reheated. This manufacturer reports that 35 triple-flow reheat units are now on order.

GAS TURBINES

Progress continued in the development of gas turbines for power generation as shown by two important orders placed during the year. One was for four 5000-kw units to be placed in service early in 1953 by the Connecticut Electric Light and Power Company for stand-by and peak-load service, and the other was a 15,000-kw unit to be installed in the Bartlesville area of the Public Service Company of Oklahoma. The latter unit is the largest of its type yet ordered for commercial operation in this country and is expected to be in service by 1953 or 1954.

Also, several 5000-hp gas turbines are reported as under construction for gas-line pumping and the Union Pacific Railroad placed an order for ten gas-turbine locomotives.

The Bituminous Coal Research Locomotive Development Committee, which is engaged in work on a pulverized-coal-burning gas-turbine power plant for railway service, reported that the problem of pressurizing pulverized coal has been solved by employing a close-clearance rotary coal pump. However, although a new fly-ash separation system removes all dust larger than 325 mesh, there still remains the problem of removing all 10-micron particles from the turbine inlet gas so as to insure against turbine-blade erosion.

ATOMIC POWER

Late in December, 1951, the Atomic Energy Commission announced that small amounts of electric power had been produced successfully from heat energy released in the operation of the experimental breeder reactor recently completed at the National Reactor Testing Station in Idaho. In trial runs on two consecutive days more than 100 kw of electric energy was produced and used to operate the pumps and other building services. It was pointed out, however, that power generation is only incidental in this case, as the principal function of this reactor is the conversion of nonfissionable material into fissionable material more rapidly than nuclear fuel is consumed.

Earlier in the year announcement was made of an arrangement made by the Atomic Energy Commission with Monsanto Chemical Company, Union Electric Company of Missouri, The Detroit Edison Company, Dow Chemical Company, Commonwealth Edison Company, Public Service Company of Northern Illinois, Pacific Gas and Electric Company, and the Bechtel Corporation whereby representatives of these firms, organized into four working groups, will be afforded an opportunity to study the practicability of private industry building and operating reactors to produce plutonium for the Government and power for industry.

Design studies for driving a submarine with atomic power were reported as having made substantial progress during the year.

OTHER DEVELOPMENTS

Among other events mentioned in the *Combustion* review was the employment of télevision in the furnace of a steam-generating unit. First applied for this purpose at the Port Jefferson Station of the Long Island Lighting Company, it permits remote observation on the boiler control panel of conditions in the furnace at all times. Other applications of the "Utiliscope" that are finding widespread use are for stack and water-level observations.

A new principle of generator cooling, termed "supercharging," made its appearance and has been applied in several installations. This involves forcing hydrogen at high velocity directly over the surfaces of the current-carrying conductors, thereby effecting a large material saving of copper and steel.

Noteworthy also is the trend, in the central-station field, toward use of miniature instruments. With panel space on control boards at a premium and the desire to have data available at more points in the steam cycle, these miniature instruments provide a logical development.

U. S. Mineral Production

RESPONDING to the urgent demands of defense mobilization, the mineral industry of the United States increased its production by almost 10 per cent in 1951, according to a year-end statement by Secretary of the Interior Oscar L. Chapman. Another substantial increase, although possibly not as great, is in prospect for 1952, the Secretary said.

The Secretary's statement was based upon a summary prepared by the Bureau of Mines, which showed an increase in the total value of mineral production in continental United States from approximately $11.8 billion in 1950 to an estimated $13.3 billion in 1951—a 13 per cent increase measured in value terms. The biggest expansion—an increase in value of over 25 per cent—occurred in metals, whose production rose from $1.3 billion in 1950 to almost $1.7 billion in 1951. Production of fuels and other nonmetals rose about 11 per cent each in total value.

These increases reflect, in part, the higher prices for minerals which prevailed during 1951. The prices of nonferrous metals, for example, increased an average of more than 20 per cent from 1950 to 1951, so that despite a value increase of 27 per cent, the actual physical increase in nonferrous-metal production was only about 3 per cent and in metal production as a whole about 9 per cent. Prices of nonferrous metals went up much more than those of most other minerals; however, the actual physical increases in production of fuels and other nonmetallic minerals were each approximately 10 per cent.

NATURAL-GAS EXPANSION CONTINUES

Production of natural gas continued its rapid rise of recent years, gaining 15 per cent over 1950. Despite restrictions initiated by the Petroleum Administration for Defense, use of natural gas by residential consumers expanded more rapidly than all others, increasing by about 27 per cent. The PAD regulations, applicable only in certain localities, restricted the number of new residential space-heating installations so as to prevent demand from exceeding existing pipe-line capacity.

Equally important with natural gas are the natural-gasoline and liquefied-petroleum gases (LPG) extracted therefrom. Sustained by the strong demand for petroleum products, in general, production of LPG increased 7 per cent in 1951 and of natural gasoline 22 per cent. Between them, they accounted in 1951 for more than 10 per cent of the total value of fuel production.

CONSTRUCTION, CHEMICAL DEMAND UP

Production of nonmetals other than fuels—mostly raw materials for the construction and chemical industries—advanced more than 10 per cent in 1951. There were substantial increases in certain areas, such as cement, whose production increased from 229 million to an estimated 247 million bbl; sand and gravel, which increased from 258 to 300 million tons;

stone, which increased from 251 million to approximately 280 million tons; and sulphur, which increased from about 5,800,000 to almost 5,900,000 tons.

National interest centered in some of the strategic minerals included in this group such as sheet mica, radio-grade quartz, talc, graphite, and asbestos. For some such minerals, exploration assistance grants by the Defense Minerals Administration (more recently Defense Minerals Exploration Administration) were of particular importance in increasing potential domestic production. Heavy imports of sheet mica, quartz crystals, and graphite will still be needed to meet domestic requirements, but the United States is approaching a high degree of self-sufficiency in block talc and kyanite.

As supplier of about 95 per cent of the world's elemental sulphur, the United States sulphur industry was under pressure throughout the year for maximum production. One of the most basic industrial chemicals, sulphur is used in the manufacture of fertilizer, in petroleum refining, in the production of steel, zinc, aluminum, magnesium, and copper, and in many other industrial applications. The International Materials Conference, which undertook during the year to allocate sulphur to the various countries of the free world, estimated a world-wide shortage of about a million tons.

DEFENSE DEMANDS MORE METALS

The demand for military "hardware," plus the heavy demand for industrial equipment and structural steel in connection with plant conversion and construction for defense production, placed a heavy strain upon most of the metals-producing industry in 1951. Widespread use of governmental limitation and allocation procedures, including a revival of the wartime Controlled Materials Plan for steel, copper, and aluminum were necessary during the course of the year to make limited metal supplies go around.

With steel-ingot production surpassing the 100-million-ton per year mark for the first time in history, iron-ore production rose to 126½ million tons from 109 million in 1950. Record quantities of ore were moved from the Mesabi deposits, both via the Great Lakes and by rail. Production of molybdenum, steel alloying element of which the United States is a heavy net exporter, rose from 14,000 tons (molybdenum content of ore) in 1950 to 19,000 in 1951; production of tungsten concentrates rose from 4000 to 6000 tons. There was a slight decline in the production of manganese. Aside from molybdenum, the United States is heavily dependent upon foreign sources for most of its ferroalloy supplies.

Copper, most important of the nonferrous metals, reached a production total (mine production) of about 950,000 tons in 1951, compared with 909,000 in 1950. The output would have been about 25,000 tons higher, were it not for strikes in the third calendar quarter. With imports of copper lower than in 1950 by possibly 25 per cent, largely as a result of the differential between the United States ceiling price and prices obtainable in international markets, the shortage of copper has been and will continue to be acute. Government assistance which has been provided in the way of loans, purchase contracts, and accelerated amortization will, because of the development time required for large new deposits, result in little increase in mine production before 1953.

Zinc production rose about 10 per cent in 1951 to approximately 685,000 tons, the highest since 1944. Lead production, on the other hand, declined. Imports of both metals, for the same reasons as copper, declined—slightly in the case of zinc and by more than half in the case of lead. Both lead and zinc production are expected to increase considerably during the next three years as a result of Government exploration grants and production expansion aids.

Gold production declined about 15 per cent in 1951 and silver production about 5 per cent. This reflects the lower gold and silver content of the base-metal ores mined in 1951.

Nickel Industry

THE free world's production of nickel for the full year of 1951 will approximate 295 million lb, an increase of more than 10 per cent over 1950, according to a review of the nickel industry by Dr. John F. Thompson, chairman and president of The International Nickel Company of Canada, Ltd., Copper Cliff, Canada.

Canadian producers, the review states, were responsible for 275 million lb, or more than 90 per cent, of the free world's total this year. In 1950, Canada produced 247 million lb of nickel in all forms.

Reliable estimates of nickel production in Soviet Russia and satellite countries are not available, according to Dr. Thompson, but trade sources believe that the free world's total is several times greater than that behind the Iron Curtain.

PRODUCTION PROGRAMS

Measures to maintain this superiority in nickel supply were taken during the year by established nickel producers as well as new potential producers, in a number of instances with government co-operation. These efforts will assure continuance of the amounts now available and are expected also by 1954 to provide an increase of approximately 30 per cent over that available before the Korean conflict.

Falconbridge Nickel Mines Ltd., Canada's second largest nickel producer, has embarked on an expansion program which its officials have stated was designed to increase nickel production from a rate of 25 million lb a year to a rate of 40 million lb annually and would require a minimum of three years to complete.

Plans of Sherritt Gordon Mines Ltd., with deposits in the Lynn Lake area of Northern Manitoba, are said to call for initial production by the end of 1953. Its annual capacity of 17 million lb of refined nickel is expected to be attained in 1955.

In July, 1951, International Nickel announced it had achieved an increase of its nickel production by 12 million lb annually, well ahead of schedule, through the installation of emergency facilities financed by the company's own resources. These facilities, initiated two weeks after the outbreak of hostilities in Korea, brought the company's current rate of production to 252 million lb annually. At the same time International Nickel continued to push its long-range underground mine development program which, when completed in 1953, will give the company the largest nonferrous-base-metal underground mining operation in the world.

Early in the year, General Services Administration announced it had completed arrangements for reopening the United States Government's Nicaro nickel plant in Cuba. The plant, with an annual capacity of 30 million lb, was operated from late 1943 to early 1947. Initial production at the reactivated plant is expected some time in 1952.

Announcement was made in October that the Defense Materials Procurement Agency in the United States had reached an agreement with National Lead Company for increased production of nickel in the United States. A new cobalt, nickel, and copper separation plant at Fredericktown, Mo., is slated for operation in the first half of 1953. This is expected to add a total of nearly 9,300,000 lb of nickel to National Lead Company's production over the next five years.

Trade reports indicate increased nickel output over the 13 to 14 million lb produced in 1951 is anticipated next year from the

nickel mines in New Caledonia, in the South Pacific. The French firm S. A. Le Nickel operates the mine.

In addition to the increased production already forseeable, wide exploration and prospecting for new nickel deposits are in process by International Nickel and others in Canada, Africa, and elsewhere.

PRICE

As a result of substantially increased labor and other production costs, the world base price of electrolytic nickel advanced six cents a lb (in terms of U. S. dollars) during the year, bringing the United States base price to 56½ cents (including the 1¼ cents U. S. import duty).

RATIONING

Supplies of nickel to industry were rationed during the entire year. In the United States a voluntary program of nickel distribution existed in the first half, based upon defense rated orders plus an equitable distribution of the balance for civilian needs. During the latter half of 1951 nickel was allocated by the National Production Authority from Washington and a metallurgical conservation section reviewed all orders in an effort to minimize the requirements for the metal. In other major countries somewhat similar controls were exercised. The National Production Authority issued order M-80 on September 1, more specifically formalizing nickel control and allocation in the United States. International allocations were initiated during October.

SCRAP

As a result of the pressure of military demands, a scrap shortage ensued which placed an increased burden on the requirements of new nickel. Nickel-consuming industries depend upon a flow of revert and customer scrap which, when unavailable, overemphasizes the demand for primary nickel. A balanced flow of scrap would help relieve present conditions.

USES

Nickel is most generally used as an alloying element. The engineering alloy steels are a vital segment of both civilian and defense economies and are used for component parts of machinery and equipment. Production of these steels in the United States was approximately 1,400,000 ingot tons higher in 1951 than in 1950. Under the direction of government agencies, downgrading of alloy content has occurred in an effort to make more nickel available for jet-engine alloys and other components necessary in a defense economy.

Total production of all types of stainless steels in 1951 was greater than in any previous year, with consumption of the chromium-nickel grades for military uses at a record high. The aircraft industries of the United States, Great Britain, and Canada with their developments of jet propulsion, are taking larger amounts of stainless steels of higher nickel content. Navy, Army, and Atomic Energy Commission requirements for these steels for equipment and materiel have been heavy. In addition, the chemical and petroleum industries have been allowed large quantities for use in the expansion of defense-supporting facilities. Therefore chromium grades have been substituted, where possible, for civilian applications in an effort to conserve nickel and this has been responsible for the increase in the total output of all varieties of stainless steels.

The age-hardenable series of nickel-chromium alloys, such as Nimonic 75, 80, and 90, Inconel X and Inconel W, continue to be used extensively in components of gas turbines and reciprocating engines for aircraft.

Production of heat and corrosion-resisting high-nickel-alloy castings was substantially higher during 1951, reflecting jet-engine components and industrial-furnace demands.

The production of nickel silver, an alloy of copper, nickel, and zinc, for civilian uses has been curtailed to divert nickel into defense products.

An instance of one way of spreading the supply of nickel is in International Nickel's new alloy, Incoloy, introduced during the year. This lower-nickel-containing alloy is being substituted for one having a much higher nickel content in many heat-resisting applications such as sheathing materials for electric-heating elements in domestic ranges and industrial heaters.

Aluminum Industry

FOR the U. S. aluminum industry, the year 1951 was one of top production, new plant projects to expand its capacity, and increasing curtailment of civilian use, according to an Aluminum Association report. Although the industry increased its primary capacity about 20 per cent during the year, curtailment in the use of the metal for nonessential purposes became more drastic as the year progressed, because of the mounting demands of defense needs, the reduction of imported metal, and the freezing of normal scrap circulation.

The year's total production of primary aluminum in the United States reached approximately 1,680,000,000 lb. This is almost 17 per cent above the 1950 production. By the close of the year the industry was producing about 5 million lb of primary metal a day—a rate that has been exceeded only during 1943, the peak-production year of World War II.

Increases in primary aluminum annual capacity so far scheduled since the outbreak of hostilities in Korea total approximately 1500 million lb. About 1100 million lb of this expansion will be in new plants and 400 million in existing plants.

Approximately 300 million lb of the 1500 million-lb total were in operation by the end of 1951. An additional 800 million lb is scheduled to begin production this year, and the remaining 400 million lb in 1953. When all of the new facilities are in operation, the industry will have double the primary capacity it had at the close of 1950, or a grand total of about 3 billion lb.

Six new reduction plants are included in the expansion program. Two will be in the Northwest, where hydroelectric power is available. The other four will be in the South, three of which will have power plants using natural gas. One plant will obtain its power supply from lignite. Four of the six plants were under construction at the close of 1951. Five of the new six plants are being built by existing producers and one by a newcomer.

Ore and ore-refining facilities are being expanded as well. New bauxite-mining operations are being developed by two producers on the island of Jamaica. Output of the mines in Arkansas and in Surinam, South America, will be stepped up as required. To increase its ore-refining capacity, the industry is building two new alumina plants and is expanding the capacity of some of the existing alumina plants. Some new fabricating equipment is being added to boost the output of certain aluminum products, but by and large the industry's existing fabricating facilities are ample to handle the increased production.

Although a portion of the industry's 1951 primary metal output went into the national stock pile, the production of fabricated products continued at a high level.

There were a number of significant new developments in application of the metal during 1951. From the research laboratory came a new alloy 10 per cent stronger than the highest-strength alloy previously in use. It is now being used on a limited scale in aircraft construction.

The forging process is being extended to larger parts of a

wider variety, particularly for aircraft. A good example is the forge-tapered wing spar announced early in the year. This part replaces about 50 smaller parts, eliminating much riveting, and saves about 50 lb in weight in the plane for which it was designed.

Two of the major automotive manufacturers introduced "laboratories on wheels"—experimental automobiles incorporating many advanced design ideas on an experimental basis. These units make significantly greater use of aluminum parts than do cars now in production. The automotive manufacturers also have begun to use aluminum die castings in increasing numbers. For some time the possible use of aluminum in automobile radiators has been under consideration and the aluminum industry has done a great deal of research on this potential application. All indications point to increased use of this lightweight metal in automobiles as soon as supply conditions permit.

An important new application announced late in the year was the use of aluminum alloy for the bases of incandescent electric lamps.

Increasing use of aluminum in materials-handling equipment has been noted, particularly in devices operated or transported manually.

Besides the enormous use of aluminum in the aircraft industry, some of the newer military uses for aluminum that have become prominent during 1951 are in: rockets and rocket launchers; bazookas; portable pipe line; pontoon bridges; prefabricated buildings; liquid-oxygen plants; PT boats and larger naval vessels; tent pins; pack boards; packaging material; and many others.

Petroleum Industry

IN 1951 the U. S. petroleum industry more than met the greatest demand in history with its greatest output of all time, a statement issued by the American Petroleum Institute revealed.

It was announced that total demand for petroleum and its products reached a new all-time peak of 2724 million bbl, an increase of almost 10 per cent over the former high established in 1950.

It was also reported that the 1951 total demand, which includes exports, was 71 per cent above that of 1941—an indication of the mounting pressure under which the oil industry has been operating for the past decade.

Factors contributing to the increase in total demand in 1951 were as follows: (1) the nation's stepped-up mobilization and defense program, which required increasing amounts of petroleum products; (2) the American people themselves who now are using more petroleum products than ever before in their homes, offices, factories, automobiles, farms, and other places, and (3) the shutdown of the Iranian oil fields and immobilization of the refinery at Abadan, a global production loss that had to be offset by the United States and other sources.

The U. S., with roughly one third of the world's oil resources, accounted for 56 per cent of the globe's total production of crude oil, an increase of 4 per cent. This was a reversal of a trend, for the United States' percentage of world production had been dropping steadily in recent years as other countries boosted their output. World production of crude oil reached an all-time high of 3986 million bbl, up almost 200 million bbl over 1950. U. S. oil exports, which had been declining since 1944, jumped to 156 million bbl for the year, an increase of 45 million bbl.

On the home front, domestic demand for petroleum increased to an estimated 2568 million bbl, the ninth consecutive year that a new peak has been set for this category. The 1951 demand averaged 7,036,000 bpd, an increase of 8 per cent (or 537,000 bpd) over 1950.

To meet this tremendous demand for more and more petroleum from the American people, the armed forces, and this country's allies, the U. S. oil industry exceeded the 2 billion bbl mark in the production of crude oil for the second time in history. This is estimated at 2245 million bbl, a record that topped the old peak of 2020 million bbl set in 1948.

Production of natural-gas liquids increased too, reaching 204 million bbl, an increase of more than 20 million bbl over 1950. Thus total production of liquid petroleum amounted to 2449 million bbl for the year, a mark that also surpassed the old 1948 peak. Gross production of natural gas in 1951 is estimated at 9 trillion 800 billion cu ft, a record in itself and an increase of 1 trillion 321 billion cu ft over the preceding year.

To convert all of this liquid petroleum into usable products, American refineries processed 2372 million bbl of crude oil in 1951.

Refinery capacity was pushed up to a new high by year's end, and this now stands at 7,230,000 bpd, compared with 1950's total of 6,963,644 bpd. This additional capacity is 46 per cent over 1941's.

Motor-fuel production surpassed the billion barrel mark for the second time in history. The total of 1132 million bbl is an increase of 10.5 per cent over 1950's peak of 1024 million bbl. Significantly, the number of motor vehicles in this country rose from 49 million in 1950 to 52 million by the end of 1951. Statistically, the 1951 production of motor fuel is equal to 47 billion 561 million gal.

Production of gas, oil, and distillates showed a 19 per cent jump in 1951, rising to 475,300,000 bbl. Residual fuel-oil production went up from 425 million bbl in 1950 to 468 million bbl in 1951. Total production of fuel oil thus exceeded 943,700,000 bbl—the highest point it has ever reached.

The continuing Dieselization of the nation's railroads played a role in this rising demand for fuel oil, as did new housing construction and the increasing number of home oil burners. During the first nine months of 1951 all but 16 of the 1856 new locomotives put into service were Diesel electrics. At the end of September almost 99 per cent of the locomotives on order were Diesel electrics. The number of home oil burners also went up again in 1951, rising to more than 5,700,000 by the end of the year.

Sales in liquefied petroleum in 1951 are estimated at about 3943 million gal, compared with 1950's total of 3 billion 428 million gallons.

To insure adequate supplies of petroleum now and in the future, the nation's oilmen had their busiest year ever in drilling operations. The number of wells completed in 1951 is estimated at 44,500—an increase of 1200 wells over 1950.

No report is available yet on the amount of oil discovered in 1951, but proved reserves undoubtedly were increased again as a result of the record-breaking level of drilling operations. At the beginning of 1951 proved reserves of liquid hydrocarbons amounted to 29,500 million bbl.

Among the many discoveries of 1951 was the Williston basin in North Dakota. This was the first commercial production in this state, and brought a whole new area into being as potential oil territory. Still another is the Richey area in Montana—an important new producing area which may add substantially to the nation's proved reserves.

Petrochemistry made further giant strides in 1951. Indicative of the growth of petrochemicals is this group of production figures covering the past quarter of a century: 1925—15,600,000 lb; 1940—1078 million lb; 1945—12,700 million lb; 1950—16,800 million lb. Although no accurate estimates are available on 1951 production, there seems to be no doubt that it in-

creased substantially over 1950. Petrochemical plants are being built at a record rate at the present. Along the Gulf Coast alone, for example, plant projects announced, started, or completed in the area between New Orleans and Brownsville, Texas, involve the expenditure of more than a quarter of a billion dollars. At the present time, about 25 per cent of all the chemicals made in this country are petrochemicals. It has been estimated that over the next decade this total will be increased to close to 50 per cent.

Bituminous Coal

THE bituminous-coal industry produced about 535 million tons of coal in 1951, according to a year-end review prepared by Bituminous Coal Institute, Washington, D. C. This amount was more than 20 million tons above the 1950 figure, and almost 100 million tons more than the 437 million-ton output of 1949.

Domestic consumption of bituminous coal amounted to 465 million tons, which was an advance of 11 million tons over 1950. Among the major markets, the steel and electric power industries each consumed in excess of 100 million tons. The steel industry used 113 million tons, a new high and a gain of 12 per cent over 1950. The electric utilities used 102 million tons in 1951, as compared with 88 million tons in 1950.

Both these markets will require considerably more coal in 1952. Steel's production goal has been raised from 105 to around 118 million tons, which if obtained, will require 15 million tons more coal for steel than in 1951.

The electric power output is steadily rising, and coal's share of total electric power generation is tending to increase. These two factors foreshadow a substantial increase in the coal tonnage which electric utilities will require in 1952.

In September, 1951, the Tennessee Valley Authority, by signing contracts committing its steam plants to the use of coal for a 10-year period, became a major buyer of this fuel for the generation of electricity. In November, the Federal Power Commission ruled against the use of gas in the TVA steam plant that is being erected at Johnsonville, Tenn. This plant will now be 100 per cent coal. TVA's consumption is estimated at 13 million tons annually by 1956, as compared with 1 million tons in 1950, and 2 million tons in 1951. In the past, 86 per cent of TVA's electricity was generated by water power and only 14 per cent by coal. Within a few years, according to present plans, coal-fired steam plants will provide about one half of TVA's total electric output.

Industries other than steel and electric utilities consumed 115 million tons of bituminous coal in 1951. In addition, Class I railroads took 55 million tons. Coal passing through the hands of retail dealers accounted for the remaining 80 million of the 465 million tons consumed in the United States in 1951. Some of the retail-dealer tonnage went to small commercial and industrial plants and other community services, but the major part went for home heating. The latest Census Bureau figures report 14 million dwelling units are heated with coal.

The export of U. S. coal to meet fuel deficiencies of Western Europe was an important factor in the 1951 coal picture. More than 37 million net tons of bituminous coal were exported to overseas destinations from January through December. Of this total, 32 million tons went to the Continent and the British Isles, as compared with less than a million tons in 1950.

The movement of U. S. coal overseas in 1952 will be even greater than it was in 1951. Government officials in recent conferences on this matter have indicated that 50 million tons might be exported if ships are available and financing arrangements can be worked out.

Shipments of U. S. bituminous coal to Canada in 1951 were approximately 22 million tons, which is a million tons less than was shipped in 1950.

Industrial stock piles and coal in retail dealers' yards rose from 72½ million in January to 78 million on November 1, 1951. Government officials have urged fuel users to store coal, and today the above-ground stocks are higher than at any other time in the past eight years.

Coal Technology Research

CONTINUATION of a nation-wide survey of known minable coking reserves, as well as conducting laboratory research to up-grade lower-rank coals to metallurgical grade, highlighted the Bureau of Mines research and technologic work on coal during the 1950 fiscal year. At the same time the Bureau maintained its activities in conservation, mining safety, synthetic fuels, anthracite problems, and related work, according to information released by the Department of the Interior.

Comprising the 15th résumé of the Bureau's broad research on coal program, the report contains citations of numerous scientific disclosures about experiments, investigations, tests, and explorations, results of which were published in separate form during the fiscal year 1950. However, the report incorporates some research data that have not been published elsewhere.

Although total coal supplies were adequate for the country's needs, the Bureau continued its estimation of known minable coking coal reserves in central and southern Pennsylvania, southern West Virginia, and in eastern Kentucky, while a diamond-drilling investigation was completed in Maryland that disclosed an estimated reserve of coking coal of about 400 million tons, of which 50 to 60 per cent were deemed recoverable.

Meanwhile, in quest of means to alleviate shortages of coal suitable for metallurgical coke, the problem was attacked in the laboratories by studies of washing and blending characteristics of low-grade coals normally not acceptable for coke making, thereby obtaining essential data on carbonizing properties of 46 domestic coals and blends, thus guiding producers in selecting proper coals for their coke ovens.

Of significance was the second underground gasification experiment at Gorgas, Ala., which was much larger in scope than the original one.

Mechanical mining practices were studied in 55 bituminous-coal mines. It was ascertained that the most difficult problem in extracting pillars with mechanized equipment is the effective control of the immediate roof and the entire overlying strata. The Bureau's activities, however, were not limited to studies alone; it actively participated in designing and testing new, untried mining machinery for anthracite mining. Preliminary underground tests on a scraper-shaker-loading machine in a rock gangway showed a maximum capacity of 150 tons per hr. Average rated capacity is 70 tons per hr. After redesigning and electrification, further tests in a coal gangway were scheduled.

Constantly striving for more progressive mining methods without sacrifice of safety, Bureau research yielded data on the effect of exhaust gases from Diesel engines used underground. The report shows that attempts to remove aldehydes from Diesel exhaust gas by scrubbing with water were not completely successful, but aqueous sodium sulphite solution, inhibited by the addition of hydroquinone to prevent oxidation of the sulphite, removed substantially all of the aldehydes and resulted in a marked reduction in odor and irritation for extended periods.

Advocated by the Bureau of Mines, roof bolting as a means of reducing the high accident rate from mine roof falls progressed considerably so that at the end of the fiscal year it was estimated that some 30 linear miles of mine roof in underground passageways were secured by that method. Other studies to further the safety of miners were continued, like finding effective methods and equipment for use against coal-mine fires. Similarly, a survey of premature firing of electric detonators showed that this hazard could be reduced by correct bonding of metallic installations.

Remarkable strides were made in using refrigeration to reduce the ventilation required to cool mines. Likewise, methods of dust control were thoroughly scrutinized by the Bureau, and a test program was initiated to test the efficacy of commercially developed devices. More than 1000 examinations were conducted to determine the concentration of air-borne dust particles. This was done in addition to the work carried out under the provisions of the Federal Coal Mine Inspection Act, and—in all—16,000 samples of air were analyzed to determine the adequacy of mine ventilation. The Bureau granted 8 new approvals and 25 extensions of approval of respiratory protective devices.

The Bureau helped effect substantial savings for other Government agencies by rendering consulting services in the purchases of fuels as well as fuel-engineering services. The Bureau advised many municipalities on smoke-abatement problems.

A study of future petroleum supply and demand was made in view of the ever-increasing demand for liquid fuels. This study indicated that by 1975—less than a quarter of a century—the bulk of the nation's oil may have to come either from foreign countries or from alternatiue domestic sources such as coal, the most abundant alternative source of liquid fuels. Quantities and characteristics of coal requisite for conversion to gasoline and oil are discussed, and cost data for products presented.

A free copy of Information Circular 7618, "Annual Report of Research and Technologic Work on Coal, Fiscal Year 1950," may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pa.

Gas-Synthesis Plant

THE second integrated test run of the U. S. Bureau of Mines' new gas-synthesis demonstration plant at Louisiana, Mo., was completed successfully, it was revealed recently by Secretary of the Interior Oscar L. Chapman.

The run lasted 25 days and marked a milestone in a research program which has greatly improved a German technique for producing gasoline and other liquid fuels from coal and adapted it to American conditions, Secretary Chapman commented.

On November 28, when a routine shutdown was made, enough raw gasoline and Diesel fuel had been produced to permit later final refining of these products to meet specifications.

Although the primary purpose of the run was to show that all phases of the process and equipment were operable and no attempt was made to obtain maximum output, John J. Forbes, Bureau Director, said "appreciable quantities" of representative products were made.

Mr. Forbes said sufficient motor-grade gasoline and Diesel oil were produced in barrel lots to permit their practical testing and evaluation.

During the run, more than 52 million cu ft of synthesis gas was made and treated to yield the synthetic-fuel products. This amount of gas required more than 700 tons of coke and 450 tons of 95 per cent pure oxygen.

The extended run followed an eight-day "shakedown" test in September, after which certain changes were made.

Successful operation of the demonstration plant at Louisiana, Mo., is a major achievement of co-ordinated research, Director Forbes stated. Over a period of several years, Bureau technologists working in laboratories, pilot plant, and the demonstration plant have co-operated effectively to bring a gas-synthesis process, adapted to American coals, from the idea stage to practical operation. It is unusual, he added, for a new plant to operate so smoothly for so long a time in an early run.

The gas-synthesis process is one of the three major methods for producing synthetic oil on which the Bureau is working intensively. The others are coal hydrogenation and the processing of oil shale.

During the recent run, from 75 to 85 per cent of the synthesis gas was converted to oil during a single pass. If the conversion can be raised to 90 per cent, the process can be operated with a single conversion stage instead of the two stages formerly considered necessary, Bureau technologists conclude.

The synthesis gas for the trial runs of the new plant was made by treating coke with oxygen and steam; however, the Bureau intends making this gas directly from coal later.

Although the Germans operated commercial gas-synthesis plants, the reactors they used for converting synthesis gas to liquid fuels were cumbersome and expensive. Up to the start of World War II, they had been unable to build a reactor with capacity of more than 20 bbl per day. This meant that a large plant would require many converters, with correspondingly high requirements for materials and operating manpower.

The type of reactor used by the Bureau of Mines, at Louisiana, Mo., requires less steel, is simple to construct, and has a capacity 6 to 8 times that of the German reactors per unit of volume. In addition, the improved reactor can be built to produce 1000 or more bbl of oil a day if desired.

A significant improvement in the reactor used at Louisiana, Mo., is the use of a low-cost catalyst. By a simple method, the Bureau recently produced 38 tons of an electrically fused catalyst, the chief ingredient of which is ordinary mill scale, a waste product of steel rolling mills.

One of the major advantages of the process used at Louisiana is that it permits using gas of the type that can be produced directly from coal, without the need of raising the ratio of hydrogen to carbon monoxide. This eliminates one step (the shift reaction) formerly considered necessary in preparing synthesis gas for conversion to oil.

Oil-Shale Tests

SUCCESSFUL completion of an analytical study of Colorado oil shale was disclosed when the Bureau of Mines published the results of tests of samples on two series of oil shale from the Mahogany Ledge of the Green River formation near Rifle, Colo.

The six-year study began in 1945 under authority of Public Law 290, approved April 5, 1944, to bolster production of synthetic liquid fuels. It was undertaken to determine the character of the various grades of oil shale that are being mined and processed into shale oil and refined products at the Bureau of Mines Oil-Shale Demonstration Plant at Rifle, Colo., and was part of a synthetic-liquid-fuels program being conducted at the Petroleum and Oil-Shale Experiment Station, Laramie, Wyo.

The importance of this research is readily understood in view of the increased demand for fuels for jet and Diesel engines. It is estimated that the Mahogany Ledge oil-shale bed alone covers an area of 1000 square miles and represents an oil reserve of 100 billion bbl, or about three times the petroleum that is recovera-

ble from wells in the nation's proved oil fields by present methods. The entire Green River formation, it was explained, covers an area of about 16,500 square miles in adjoining portions of Utah, Colorado, and Wyoming.

A total of 16 tough rocky oil shales, with colors ranging from gray brown to dark brown, were sampled. The dark brown assayed 75 gal of oil per ton, and the gray brown assayed 10.5 gal of oil per ton. The shale used in this study was obtained from the Mahogany Ledge, the richest part of the Green River formation. With an average oil yield of about 30 gal per ton of shale, this is considered the most suitable section for commercial exploitation.

The report shows that the organic material in minable-bed shales yielded, on the average, 66.3 per cent oil, 9.1 per cent gas, and 24.6 per cent organic residue, which means that approximately three fourths of the organic material in the shale was converted to oil and gas while one fourth was residue that remained on the spent shale. Data on sulphur and nitrogen occurring in the shale are also given.

Exposed to normal weather conditions at Laramie, Wyo., ground shale showed no significant reduction in oil yield after exposure up to six months. Shale exposed for 5 years yielded on the average of 5.4 gal of oil per ton less, or a loss of 11.4 per cent.

A free copy of Report of Investigations 4825, "Properties of Colorado Oil Shale," may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh, 13, Pa.

Rubber

WORLD stocks of crude rubber, excluding those behind the Iron Curtain, totaled approximately 1,800,000 long tons at the year end, or about 570,000 tons more than was available in the world at the time of Pearl Harbor, according to John L. Collyer, president of The B. F. Goodrich Company, Akron, Ohio.

World production of man-made rubbers, about 95 per cent of which is in the United States, is currently at a rate approaching one million long tons a year and may soon exceed 1,100,000 tons annually. At Pearl Harbor, such capacity was only a few thousand tons a year.

The total world output of crude and man-made rubbers this year should be about 2,900,000 long tons while world consumption is expected to be less than 2,500,000 long tons, thereby making available 400,000 long tons for addition to stocks in 1952, Mr. Collyer reported.

The United States now has all the man-made rubbers that it can effectively consume in the manufacture of civilian and defense products and has built up stocks of sufficient size to permit government authorization for the export of some American-made rubbers to friendly nations, he said.

Crude-rubber stocks in the United States at the end of 1951 totaled about 850,000 long tons and stocks of man-made rubbers totaled about 130,000 tons. Consumption of new rubber by the United States in 1951 totaled 1,230,000 tons. Estimated consumption for 1952 is 1,300,000 tons, which if attained will be a new all-time high. Sixty-five per cent of the consumption will be American rubber and 35 per cent crude rubber.

Plastics

THE plastics raw-material-supply situation has improved substantially from a year ago, according to William T. Cruse, executive vice-president of The Society of the Plastics Industry, Inc. While one or two of the scores of different types of plastics are still a bit tight, in the main, plastics raw materials are generally available.

This condition is due to several causes. By a planned and organized program of concerted action, the plastics industry through SPI was able to correct the polystyrene plastics shortage of 12 months ago by proposing and then securing imports of benzene from France and Western Germany from which styrene was obtained to make polystyrene plastics. Also, additional benzene was procured from petroleum production which increased the available styrene for polystyrene plastics.

In addition, the plastics industry through SPI secured the return from Rubber Reserve of unused styrene, when the synthetic-rubber program did not meet anticipated production schedules. Additional plant facilities for the production of plastics materials, such as polystyrene, polyethylene, and the phenolics, have contributed substantially to relieving the supply situation for the molder and fabricator.

More new plants will be completed in 1952 for the production of plastics raw materials. These plants and those completed in 1951 are an indication of the decentralization of manufacturing now taking place in the plastics industry. New plants have appeared on the West Coast and in several southern states.

In the United States today there are in the neighborhood of 5000 plastics companies. These concerns, which will produce more than a billion dollars' worth of plastics products in 1952, produce these products by molding, extruding, laminating, reinforcing, calendering, casting, and the like.

This year's production of synthetic resins from which all plastics products are made, it is estimated, will be up approximately 10 per cent to 2600 million lb. This compares with an estimated 2365 million lb for 1951 and an actual production of 2,150,518,000 lb in 1950.

Military applications for plastics have increased substantially as products are developed from the different plastic raw materials which will withstand temperature extremes, the abuse that military products must take, and the lightness of weight required for easy handling by personnel.

Consumer applications for plastics products also continue to increase, but this development has been affected somewhat by the shortage of certain plastics raw materials the first part of last year and the present cutback in the production of certain consumer items due to the country's military program.

The plastic raw-material-supply situation, as 1952 began, was as follows: Phenolics, supply about normal; ureas, supply normal; melamine, supply adequate, but future potential military demand may affect this supply later this year; cellulose acetate, normal supply; cellulose acetate butyrate, normal supply as production recently increased; ethyl cellulose, normal supply, but future military requirements may alter this situation; acrylics, normal supply; polystyrene, normal supply, which is just the opposite from last year at this time when supplies were extremely short; vinyls, normal supply; nylon (plastic type), normal supply for reasonable civilian uses; polyethylene, still in short supply, but increasing production is relieving this situation to some extent; polyesters, normal supply, but coming military programs may alter this situation.

High-Temperature Resin

A NEW polyester laminating resin which will withstand temperatures as high as 500 F has been developed by Naugatuck Chemical Division of the United States Rubber Company. The resin is expected to find its most significant use as a structural material in the manufacture of high-speed

aircraft and guided missiles and is now being tested for this type of application at the Wright Air Development Center.

The new resin has physical and handling properties comparable to other types of polyesters now available with the added benefit of high strength at high temperatures.

Laminates made with the resin and glass fabric are reported to retain good flexural strength (40,000 to 47,000 psi) when exposed for as long as 200 hr at a temperature of 300 F. Good flexural strength (over 30,000 psi) is also obtained when exposed for as long as 24 hr at 500 F. The heat-resisting properties of the resin are made possible by the use of a new chemical, triallyl cyanurate.

Initially, the resin will be available for military applications. However, Naugatuck Chemical is boosting production capacity in order to supply resin fabricators who require heat resistance for applications in the electronic, radio, and television industries. It is being marketed as Vibrin X-1047.

Radioactivity Instrument

PORTABLE self-contained radioactivity survey instruments of the gamma type generally use a microammeter to indicate the radiation level. Ideally, these survey instruments should be low in cost as well as compact and rugged. Yet microammeters are inherently neither cheap nor rugged, nor are they suited to mass production in extremely large volume. A new gamma survey instrument, recently developed at the National Bureau of Standards electronic instrumentation laboratory, requires no microammeter.

In the NBS instrument, which was developed for the Navy Bureau of Ships, radiation levels are read directly from a potentiometer dial. To read an unknown value of radiation, the operator turns the dial to the point at which an audio oscillation just begins. This point is determined aurally with a small earphone that is standard equipment for most survey instruments. This aural indication is particularly convenient for plotting contours of equal radioactivity; with the dial set for a particular radiation level, it is an easy matter for the operator to walk along and locate aurally a series of equally radioactive points.

Like many other gamma-radiation survey instruments, the NBS device uses a detector tube of the halogen-filled GM type, together with a vibrator high-voltage power supply operating from flashlight-type batteries. Output current of the detector is proportional to the incident radiation.

FIG. 1 NEW RADIOACTIVITY SURVEY INSTRUMENT RECENTLY DEVELOPED BY THE NATIONAL BUREAU OF STANDARDS

The heart of the aural indication method is a thyratron relaxation oscillator circuit. If the potential difference between the grid and cathode of the thyratron exceeds the firing potential, the circuit will oscillate. The unknown voltage derived from the detector-tube current is applied to the outer terminals of the potentiometer, while the thyratron grid is connected to the moving contact. The potentiometer setting at the threshold of oscillation thus depends on the radiation level, and the potentiometer dial can be calibrated directly in radiation units.

Oak Ridge Pile

THE Atomic Energy Commission recently has made public a number of details of its uranium-graphite nuclear reactor at Oak Ridge, Tenn., as part of a program to speed training of technical personnel. See Figs. 2 to 4.

Newly declassified information on this atomic furnace, widely called the Oak Ridge pile, includes dimensions and other physical aspects, plus facts on pile operation. Low-power reactors such as this one at Oak Ridge cannot be used for practical production of materials for atomic weapons.

Known as the world's current principal producer of radioisotopes, and used now in research activities, the pile is a key facility at Oak Ridge National Laboratory. ORNL is operated for the AEC by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation.

The air-cooled reactor was built in the early days of the wartime atomic-bomb project, to serve as a pilot plant for the large-scale plutonium production reactors at Hanford, Wash. It first went into operation on Nov. 4, 1943.

It has been disclosed that the Oak Ridge reactor, long known to be a cube of graphite containing a number of horizontal channels for uranium-fuel cylinders, is actually a 24-ft cube built of stacks of graphite blocks. Each block is 4 in. wide, 4 in. high, and most of them are 4 ft long.

A total of 1248 parallel fuel channels 8 in. apart, laces the graphite cube.

Round 4-in-long slugs of normal uranium in gastight aluminum jackets may be lined up end to end in these channels, 39 to 54 slugs in a row. Weighing 2.57 lb each, and measuring 1.1 in. in diam, the slugs are placed to permit easy passage of the air that cools the pile. The fuel channels are diamond-shaped, with sides of $1^3/_4$ in. each.

The graphite cube (called the moderator), surrounded immediately by air space, sits within a shell of 7-ft-thick concrete shielding. The shield structure itself is 47 ft long, 38 ft wide, and 32 ft high, and is sheltered by a barnlike corrugated iron building.

Behind the 7-ft concrete shield on the loading face of the pile is a 3-ft air space, then the 24-ft moderator. At the back of the pile, a 6-ft air space separates the moderator and the concrete shield.

The fissions which go on within the reactor when it is "on" produce energy, mostly as heat, measured in kilowatts. The pile was designed to operate at 1000 kw capacity, but now has a 3800-kw power level.

During pile operation, the maximum temperature of the uranium fuel is 245 C. The average temperature of the graphite moderator is 130 C. Powerful fans draw air through the reactor at the rate of 100,000 cfm to keep down the temperature of the moderator and fuel.

Shutdowns occur at least weekly, for withdrawals of radioisotopes, insertion of new material to be irradiated, for maintenance work, and occasionally the insertion of a number of fresh uranium-fuel slugs.

FIG. 2 TO INSERT NEW URANIUM-FUEL SLUGS, OPERATORS REMOVE A 5-FT-LONG PLUG FROM THE LOADING FACE OF THE PILE

(Plugs are steel pipe filled with lead shot and paraffin. As one man withdraws plug, the other, wearing safety glasses, uses a rag to wipe off possible flecks of foreign matter that might be radioactive. Wires, tubes, and other paraphernalia on the wall are parts of devices used in a variety of research activities.)

FIG. 4 OPERATOR PLACES ALUMINUM-JACKETED URANIUM SLUGS IN A FUEL CHANNEL OPENING ON THE LOADING FACE OF THE REACTOR

(Slugs are placed end to end in rows of 39 to 54 in each channel. Openings in the shield are round, but each channel in the graphite cube itself is diamond-shaped. Thus the slug, when in place, does not fill the channel. This permits passage of cooling air being pulled through the reactor by exhaust fans.)

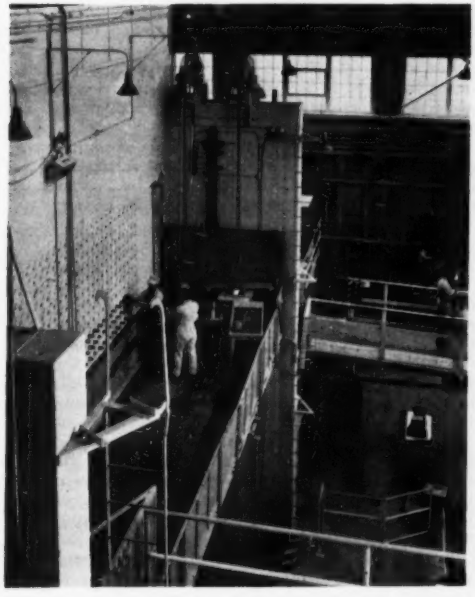

FIG. 3 PREPARING TO REMOVE PLUGS FROM SOME OF THE 1248 FUEL-CHANNEL OPENINGS IN THE SHIELD OF THE GRAPHITE REACTOR

(In brackets on the wall of the elevator, in front of the two men, can be seen a horizontal bundle of 10-ft lengths of light steel poles used as "push rods." As a rod is inserted to a channel, another rod is threaded to it, increasing its length to permit traversing the length of the fuel channel.)

FIG. 5 AFTER SLUGS ARE INSERTED IN THE CHANNELS, LONG STEEL PUSH RODS ARE USED TO PLACE SLUGS IN THE PROPER POSITION

(As a new slug is shoved in, it forces a "spent" slug out the back of the reactor. The slug drops to an inclined, neoprene-covered pad, from which it is funneled into a chute leading to a 20-ft-deep pool of water. The slugs are caught in a bucket at the bottom of the pool, and because of their radioactivity, must be handled under water.)

Air Pollution

INDUSTRY has made distinct progress toward eliminating fly ash, soot, dust, fumes, and odors that are being discharged into the atmosphere. Societies, such as ASME and the Air Pollution and Smoke Prevention Association of America, have entered into the picture along with research organizations, city municipalities, and the Federal government.

Research developments at Battelle Memorial Institute, Bituminous Research Institute, Mellon Institute, and others have gone all out in classifying types of contaminants, developing methods of collecting, and recommending steps necessary to alleviate the nuisance at its source.

In addition to these research organizations, manufacturers of collecting equipment have continually placed emphasis on bettering their equipment and finding new and more diversified means of collecting the various contaminants that enter the air. These equipment manufacturing companies have cooperated to the fullest extent with industry in the abatement of air pollution.

To give the complete picture of what is ahead of industry in its campaign of smoke abatement and reduction of air pollution, the January, 1952, issue of *Industry and Power* contains a special report on "Contaminants in the Air."

This special report gives a description of various types of contaminants that are discharged to the air. Emphasis is placed upon the source of such contaminant and its ultimate effect upon the community. Legal aspects of air pollution and a briefing of the municipal codes give the Engineered Plant Service group an insight as to what local and Federal governments are now doing and plan to do to help industry cope with this problem.

Modern collecting equipment is presented, and an endeavor is made to aid the engineer in the ultimate selection of the proper unit, regardless of contaminant type.

Coal Pipe Line

A DEMONSTRATION-SIZE pipe-line project for transporting coal has been placed in experimental operation by the Research and Development Division of Pittsburgh Consolidation Coal Company.

This coal-carrying pipe-line system, installed near Cadiz, Ohio, and adjacent to the Hanna Coal Division's new George-

FIG. 6 DEMONSTRATION-SIZE PIPE-LINE PROJECT INSTALLED NEAR CADIZ, OHIO

(In foreground is a section of the 12-in. line prior to being buried underground below the frost line. In background on the left is the crusher building; on the right is the slurry-preparation plant.)

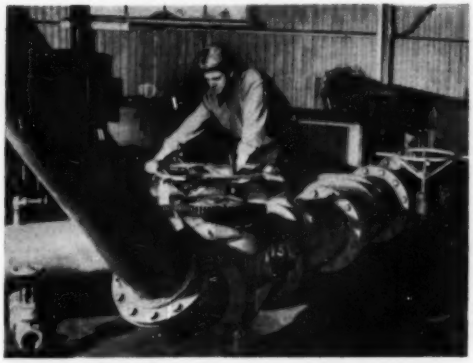

FIG. 7 FLOW OF SLURRY FROM ONE LOOP OF PIPE LINE TO ANOTHER IS SHOWN BEING DIVERTED

town Preparation Plant, simulates a commercial operation both as to equipment and conditions of topography.

Using 12$^{3}/_{4}$-in-diam pipe, from 7000 to 9000 tons of coal are moved through the system daily. Coal which has been crushed to fine size is mixed with water to form a "slurry" and this mixture is pumped through the pipe line under pressure.

The coal is picked up by conveyer and brought to a crusher building where it is prepared to a specific size depending upon experiment requirements. From the crusher building it travels by conveyer to a slurry-preparation plant where the crushed coal is mixed with water and piped into the lines. Return lines send it back to the slurry-preparation building where the slurry continues to make the rounds through the pipes.

The experimental pipe-line project will be operated for the better part of a year, the company states, in accumulating and evaluating data required before a decision on a commercial-size pipe-line system can be made.

Ore Pipe Line

A 7$^{1}/_{2}$-MILE pipe line has been completed by The International Nickel Company of Canada, Ltd., through which the bulk concentrate from 3,650,000 tons of nickel-copper ore is being pumped annually from its newly built Creighton concentrator to its reduction plants at Copper Cliff. It is believed that never before has concentrate been carried by pipe line in such quantity over such a distance.

The pipe line, it was announced, reduces the time required to transform nickel ore into refined nickel. Further, the economics resulting from pipe-line transportation, together with other economics, have made possible the working of lower-grade Creighton ore which is now contributing to the availability of nickel for the defense production needs.

Part of International Nickel's $130 million program of underground mine expansion, the pipe-line artery has been integrated into an elaborate pipe-line system which also carries tailing, or waste material, from both Creighton and Copper Cliff to a disposal area midway between the two plants.

The system has 12 miles of trestle, at some points 65 ft high to assure a slope to and from each of the five relay pumping stations so that the concentrate lines will be self-draining in case of power difficulties. All told, 3 million bd-ft of lumber and 40 miles of wooden pipe were used.

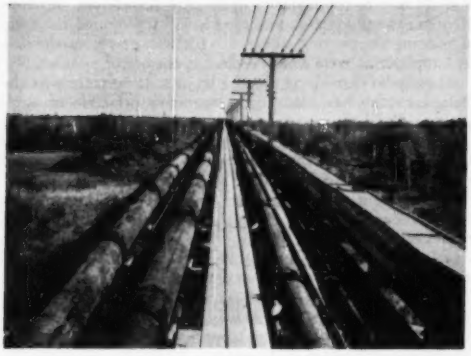

FIG. 8 TAILING, CONCENTRATE, AND WATER LINES ON NEW NICKEL-ORE PIPE LINE

When milling 10,000 tons of nickel-copper ore a day at Creighton, approximately 1800 tons of concentrate and 8200 tons of tailing are produced. Water added to the concentrate makes a pulp which flows through the pipe line at the rate of 800 gpm. The tailing pulp flows at the rate of 2500 gpm.

Despite the rigorous northern winter weather, the complete pumping system has been designed for trouble-free operation. Several times the temperature has dropped to 30 deg below zero with no operating difficulties.

Jet Airliner Service

JET air routes will span the globe by 1954–1955 if plans now being made by six of the world's airlines are fulfilled, according to The Society of British Aircraft Constructors. The six operators, all who are scheduled to use Comets, have plans for jet services running to every continent and major city—from London to Sydney, Auckland to San Francisco, and New York back to London.

The only gap at present in this planned jet encirclement of the world is the land route across Canada and the United States.

British Overseas Airways Corporation will open the global network with passenger-carrying Comets flying out to Cairo and Johannesburg in April this year. As BOAC takes delivery of Comets, it will spread the jet routes and increase the number of services by flying on through India and Pakistan to Singapore and out to Australia. BOAC is expected to add to its fleet of nine Series 1 (Ghost) Comets and five Series 2 (Avons) by ordering more Series 2 long-range types.

Later in 1952 Canadian Pacific Airlines will take delivery of two Series 1 Comets which will carry the Australian service up across the Pacific as far as Honolulu. Based in Sydney, the Comets will work two services, one via Fiji and Canton, the other across to New Zealand and on to Hawaii.

The link between Honolulu and San Francisco and Vancouver will be opened in 1954—when British Commonwealth Pacific Airlines takes delivery of the first of its six Series 2 Comets, and starts the jet service between Canada, the U.S.A., and Australasia.

The first jet route from the east coast of the United States will be BOAC's run from New York to Nassau. Later, when the long-range Avon Comets are delivered, they will probably open a high-speed stopping service across the Atlantic to London.

A second 500-mph trans-Atlantic service is contemplated by Panair do Brasil, who have an option on three long-range Comets, for the trunk routes from Rio de Janeiro to Lisbon, London, and Paris.

Africa and the Middle and Far East will be spanned by four airlines—by BOAC, by Air France (with three Series 1's), by the French charter company Union Aeromaritime de Transport (three Series 1's), and by Panair's extended routes to Istanbul and Beyrouth.

Turnover Conveyer Belt

A NEW type of conveyer belt that allows a steady stream of vitally needed iron ore to move out of underground mines and into surface stockpiles in freezing weather has been developed jointly by the B. F. Goodrich Company, Akron, Ohio, and the Chain Belt Company, Milwaukee, Wis.

The conveyer system overcomes operating hazards found in the subzero weather normal to Minnesota and Michigan iron ranges in winter. Until now, belt systems conveying ore from mine to carrier shut down for four months, starting about December 1, due to difficulties met in temperatures as low as —40 F.

Ore from an increasing number of all-year-round mining operations must be stockpiled during winter months since lake freighters cannot transport ore to steelmaking centers when harbors and locks are frozen solid.

The new conveyer system features a "turnover" arrangement of the belts. This makes practical year-round operation of conveyer belts for easy, efficient winter stockpiling.

Spring shipments of ore will be speeded too, since ore can be stockpiled by conveyer belt in such a way that piles do not freeze solid. It is not unusual for stockpiles, created by dumping ore from mine cars, a method that does not provide a constant stream, to remain frozen solid through July. Time is lost when these stocks must be blasted to loosen ore for shipment.

According to B. F. Goodrich, the new conveyer system enables the belt to turn itself over after delivering its load. Thus the clean side of the belt always runs on top of the return idlers and cannot clog or cause damaging build-up of tacky

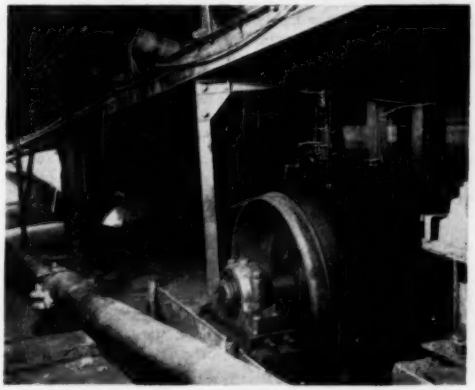

FIG. 9 NEW TURNOVER-BELT-CONVEYER SYSTEM

(Return strand of belt, at bottom, moves from right to left with carrying surface of the belt being brought uppermost at extreme left. The 180-deg twist of this 36-in-wide belt is made in the 36-ft distance shown here.)

materials on idlers or pulleys. Before accepting a new load, the belt takes another twist so that the same carrying surface as before received the load. At each end the belt is twisted 180 deg.

The turnover belt action is accomplished by positioning two twist pulleys at each end of the system. It is an easy matter to convert any conventional belt-conveyer system into the turnover type.

Sticky material cannot accumulate on rotating metal parts of the system and wet materials can be handled at subzero temperatures without danger of the belt freezing to pulleys and idlers.

With the turnover-belt-conveyer system, clean-up problems as a result of spillage are said to be greatly lessened, and the use of deck-plates to protect the return run is eliminated. Any spillage onto the lower run is carried to the tail end and automatically dumped, for subsequent reclaiming.

The system is recommended by B. F. Goodrich wherever messy, sticky materials must be handled.

Electrolytic Metal Cutting

SECTIONING of metal bars by electrolytic methods—to safeguard personnel against the hazard of machine cutting of metals exposed to high levels of atomic radiation—has been accomplished at the Columbia University School of Engineering under a grant from the Atomic Energy Commission, Dr. John R. Dunning, Mem. ASME, dean of engineering, announced recently.

This is believed to be the first successful electrolytic cutting of metal in the United States. It was developed by George L. Kehl, associate professor of metallurgy, and Irving Moch, Jr., research associate.

Professor Kehl explained that it would be impractical to use conventional methods in cutting material which has been exposed to considerable atomic radiation, not only because of the danger to the men, but also because the surroundings would be contaminated.

The method, it is reported, can be applied, when it is desirable, to cut metal bars without causing structural distortion on the cut surfaces.

Steel bars $^5/_8$ in. in diam have been cut in about 24 hr by the new process, Professor Kehl said, and the cut surfaces are comparable in flatness and smoothness to the results attained by moderately fine machining methods.

He predicted that with further development of the process, very smooth and polished surfaces can be obtained.

The process consists of making the specimen to be cut the anode in an electrolytic cell and using an appropriate electrolyte and cathode assembly. The flatness of the cut surface is produced by a novel design of cathode assembly which is the principal invention of the process.

Century of Engineering

ON the occasion of the Centennial of Engineering, which will be observed this year by the American Society of Civil Engineers in co-operation with ASME and other engineering organizations, it is fitting that some of the more important engineering achievements of the past century be noted. To accomplish this, Dr. John R. Dunning, Mem. ASME, dean of engineering at Columbia University, polled the editors of 32 leading technical journals and business publications to find out what has been the most significant development in their particular field of engineering in the past century.

According to the majority opinion of the editors, developments in the production and use of steel represented the most significant engineering advance. Electric power production and application were a close second in the editor's choice.

Those who chose steel pointed to such achievements as the Bessemer converter, Siemens regenerative principle of steelmaking, the construction of high-speed continuous mills for rolling steel strip and sheet, the skeleton frame-curtain wall concept of building, the development of a host of alloys, and the improvements in the quality of steel.

It was pointed out, for example, that forward strides (in mass production) may usually be traced to development of alloys capable of doing the job. The gas turbine waited upon development of heat-resistant alloys, and the jet-engine development for aircraft is progressing only as fast as materials can be developed that can stand the heat, the strain, and the abrasion, and still be machined. There have also been alloys of aluminum, magnesium, titanium, copper, and nickel that have changed the course of the world.

The most significant single development in the use of steel, in the view of the editors, is the application of the steel frame to structures.

Those editors who considered the use of electric power of foremost importance listed as major developments the invention of the electric dynamo, the harnessing of hydroelectric power, the introduction of the alternating power system, the construction of the central-station steam-power plant, and the invention of the incandescent lamp.

Other major developments listed by the editors included the following: The atomic bomb, assembly-line production, reinforced and prestressed concrete, the telephone, heavier-than-air craft, the vacuum tube, interchangeable parts, the gage block, drilling and blasting by means of dynamite and the pneumatic rock drill, the flotation process, automatic central heating with oil and gas, air conditioning, the concrete highway, mechanized construction equipment, methods for disposal of human, animal, and industrial wastes, antibiotics, the internal-combustion engine, the Diesel engine, the gas-turbine engine, the high-speed electronic digital computer, the high-pressure still, the continuous-flow chemical plant, pulverized-coal firing, geophysical prospecting and the general application of geological science to mining, the electrolytic separation of aluminum, the tin can for food packing, the construction of turbojet, turboprop, and rocket power plants in aircraft, and the cracking process in petroleum.

Technologists on the staff of *Fortune* selected their choices by field, as follows:

Civil engineering—the concrete highway, the steel skeleton structure, the hydroelectric power dam.

Mechanical engineering—the conveyer belt, the Ottocycle internal-combustion engine, the Diesel engine, the gas-turbine engine.

Electrical engineering—the central-station steam-power plant, the electronic tube or electronics, the high-speed electronic digital computer.

Chemical engineering—the high-pressure still, the continuous-flow chemical plant.

According to Dr. Dunning, these choices by *Fortune* most of them dealing directly or indirectly with the use of steel, and many of them with the production or use of electricity, seemed to sum up the thinking of the majority of the editors who were polled.

The scope of this list, Dr. Dunning emphasized, provides impressive proof that the past century of engineering which we are about to celebrate has resulted in the greatest material progress of any century in the history of the world.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Furnace Performance Factors

An Investigation of the Variation in Heat Absorption in a Natural-Gas-Fired, Water-Cooled Steam-Boiler Furnace, by A. R. Mumford, Fellow ASME, Combustion Engineering-Superheater, Inc., New York, N. Y., and R. C. Corey, Mem. ASME, United States Bureau of Mines, Pittsburgh, Pa. 1951 ASME Annual Meeting paper No. 51—A-147 out of stock; to be published in Trans. ASME).

THIS report covers the first comprehensive study of the distribution of heat absorption in a natural-gas-fired water-cooled steam-boiler furnace. The use of a fuel free of incombustible residue revealed factors in furnace performance because ash was not present to mask the influence of such factors.

The tube surface temperatures on the furnace walls were essentially constant at any given rating and excess air and were completely reproducible. After a lapse of more than a week a check test was made and it was found that the indicated tube surface temperatures were within a degree or two of their previous values. The obvious conclusion is that the shape of the "flame" envelope (invisible with natural gas) was independent of load at least with fixed burner position and at fixed mixing vane angles. There is no reason to suppose that the flame envelope and gas path in a furnace fired with pulverized coal would not also be the same at the same rating and excess air and with fixed positions of burners and mixing devices. This factor has not been apparent on previous tests because of the masking effect of variable ash deposits on the furnace tube surfaces.

The test boiler, in normal service was used at high load factor and high capacity. The mixing vanes and flows in the burners had been properly adjusted for this load condition after extended experience. Readjustment for each test load would have been time consuming so vane adjustment was not attempted. When isotherms were drawn on plots of the furnace walls it was strikingly apparent that the pattern was similar at all loads with eight burners and with four burners. The gradient, or space between isotherms, varied with rating but the pattern was constant. This constancy of pattern indicated that as long as burners and mixing devices were not readjusted, the hot gases would impinge on the walls at the same spots at all ratings and, therefore, that the path of gases through a furnace is determined by the burner position and the geometry of the furnace and not significantly by rating or excess air. This factor was not apparent from the results of the previous pulverized-coal-fired tests because of the masking action of the ash deposits on the surface of the furnace tubes.

The usual flame, as observed in coal- and oil-fired furnaces, was completely invisible in this natural-gas-fired furnace. Computations of radiant transfer indicate that about 80 per cent of the heat absorbed by the furnace was transferred by radiation. Estimates for luminous flames indicated that from 95 to 100 per cent of the heat absorbed in the furnace is transferred by radiation.

In the first attempts to measure the furnace gas temperature at the burner level several impressive occurrences indicated that much higher temperatures were being dealt with than were expected. The porcelain shields, used to reduce radiation loss, shattered upon reaching the hot gases. The platinum and even the platinum-rhodium wires of the thermocouple melted. The analysis of the data indicated, by extrapolation, that temperatures of 3400 F were common within 10 ft of the burner. Such temperatures indicated effective mixing of fuel and air and very rapid combustion. Conservative estimates of heat release indicated values of 160,000 Btu per cu ft of space utilized for the completion of combustion. When the velocities of gas and air were lowered, for testing at lower loads, temperature measurements indicated that the mixing action was not as effective because the burner vanes were not readjusted to compensate for the reduced velocities. At partial loads studies of the gas temperature measurements indicated that the impingement of the hot gases on the rear or target wall produced sufficient mixing to complete combustion at the burner level. No unburned products were found in the gas samples taken

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above the burner level at any load. It can be concluded, therefore, that with sufficient hot-air pressure and with a well-designed mixing burner, natural gas can be burned rapidly and completely at high heat-release rates.

The temperatures of the gases leaving the furnace at constant steam load decreased with increase in excess air but the heat content of the mixture increased. The patterns of the isotherms of gas temperature at the furnace outlet vary markedly with the load. The addition of a widely spaced screen of tubes in front of the rear wall reduced the gas temperatures leaving the furnace from 50 to 100 F but also changed the pattern of the isotherms so that the pattern was essentially the same at all loads. Probably the furnace wall screen not only absorbed additional heat but also aided in the mixing action of the gases impinging on the wall and thus made the isotherms more uniform.

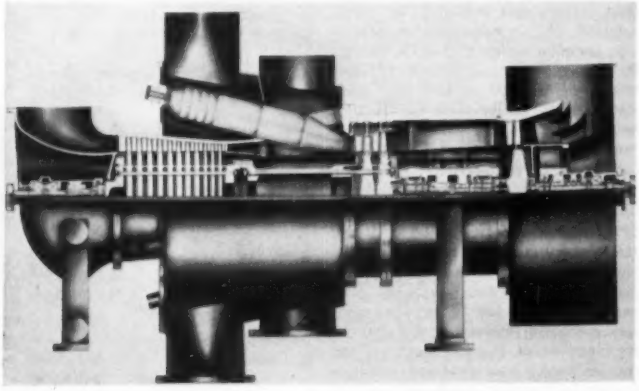
Gas Turbine Power

The Gas Turbine's Contribution to Gas-Pipe-Line Pumping, by T. J. Putz, Mem. ASME, Westinghouse Electric Corporation, Philadelphia, Pa. 1951 ASME Annual Meeting paper No. 51—A-102 (mimeographed).

THE current total annual consumption of natural gas in the United States is now over 5 trillion cu ft not counting that used for repressurizing, field fuel, and losses. Approximately 35 per cent of this gas was used in refineries and in producing carbon black. Such use which occurs within or close to the producing or gathering fields does not require pipe-line transportation. The other 65 per cent is pipe-line gas. Various authorities have estimated that the amount of gas transported through pipe lines will be doubled in the next 10 or 20 years. To handle this increase, a conservative estimate shows that an addition of 4 million compressor hp will be needed.

Comparative studies have been made to determine the economic advantages between the gas-turbine-driven centrifugal compressor and the conventional direct-driven reciprocating-gas-engine units. One study was made using these drives to fully develop a theoretical transmission line 1000 miles in length. This study was based on the assumption that complete spare units would be available to maintain design flow capacity in the event of shutdown of one unit. The result of this study showed that a 26-in-OD pipe line could be economically developed to the same delivery capacity with a gas-turbine-driven centrifugal compressor as a 30-in-OD line with reciprocating engines.

In May, 1949, Westinghouse placed in service an 1800-hp gas turbine driving an Ingersoll-Rand direct-connected centrifugal gas compressor in a test station on a natural-gas line at Wilmar, Ark. This was the first such installation in the world and the first industrial gas turbine in the United States operating with natural-gas fuel. This test installation was on the 22-in. line of Mississippi River Fuel Corporation connecting Monroe, La., with St. Louis, Mo. It was located approximately midway between two conventional-engine-driven stations at Crossett and Glendale. This location provided great flexibility in that it gave an opportunity to test the gas turbine and the centrifugal gas compressor over their entire operating ranges. The unit was operated at the Wilmar location until the fall of 1950. At that time the Mississippi River Fuel Corporation completed installation of a parallel high-pressure line, which eliminated need for the unit in this location. It was then moved to Farmington, Mo., approximately 60 miles below St. Louis, and placed in service in January, 1951. At this new location it is used to "pack" the underground storage field recently acquired by this gas company near St. Louis.



LONGITUDINAL CROSS SECTION OF 5000-HP GAS-TURBINE UNIT FOR LARGE MAIN TRANSMISSION LINES

Based on the operating experience gained with the 1800-hp simple single-shaft unit in pipe-line pumping service and the results of detailed studies of main transmission-line pumping requirements, Westinghouse has designed and is building a 5000-hp dual-shaft gas turbine with regenerator. The unit will have an 11-stage axial-flow compressor, six combustors, two-stage compressor-drive turbine, and a single-stage power turbine. With this arrangement the power turbine and gas compressor speed and load can be adjusted to suit varying pipe-line flow conditions. The speed of the compressor and the compressor drive turbine is 6200 rpm while that of the drive turbine is 6500 rpm at nominal full-load power rating. The regenerator which recovers approximately 75 per cent of the available heat in the exhaust gases is of the extended-surface type.

The contribution the gas turbine can make to the major gas-transmission systems in lines 20 in. and larger in diam will be in the form of reduced capital investment for stations and lines and a lower cost per unit of gas transported as compared to gas-engine-driven reciprocating equipment. In specific cases additional advantages will arise from station simplicity, freedom from large water-supply problems, reduced maintenance, and ease of adaptation for remote control or unattended operation. In addition, the gas turbine's characteristic of increasing power with low ambients gives it extra rating in the winter months when the demand for gas is greatest. The overall suitability of the characteristics of the gas turbine-centrifugal compressor combination of high-flow low pressure ratio make it ideal in booster service. To these advantages can be added the probability that owing to the restrictions on the use of steel, emphasis will be given to increasing the capacity of existing lines by adding boosters in intermediate stations. The extent to

which the gas turbine will capture this market, for which it is ideally suited, is dependent on its acceptance by operating companies as a reliable unit.

Design and Performance of an Extended-Surface Regenerator for a Gas-Turbine Plant, by Sven Holm, Mem. ASME, and Ray L. Lyerly, Jun. ASME, Air Preheater Corporation, Wellsville, N. Y. 1951 ASME Annual Meeting paper No. 51—A-106 (mimeographed).

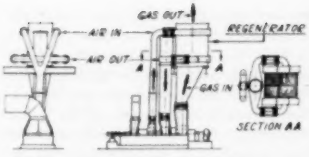
A NEW type of extended-surface heat exchanger developed for application to a gas-turbine plant for a natural-gas pipeline pumping station is described. This regenerator features compactness and low weight. However, the particular unit described is not as compact and light as could be made since primary consideration was given to material strength and service life, thus involving the use of relatively heavy sections for both primary and extended surfaces. Smaller-scale component parts would give higher heat-transfer coefficients and increase the heating surface per unit volume by as much as three to one

The basic requirements for a regenerator in this gas-turbine plant were an air-side temperature effectiveness of 75 per cent, relatively low pressure drops, and a long service life with natural gas as the fuel in the cycle.

The plant is arranged so that the air from the compressor enters the regenerator on both sides at the top and leaves the regenerator from both sides at the bottom. The expanded gases from the turbine pass upward through the heater in true counterflow relationship to the air and exhaust through a stack and weather hood. All ductwork is equipped with expansion joints of the universal type and self-restrained hinge type to relieve the regenerator and other machinery of loads imposed by thermal expansion.

The gas-turbine plant was erected at the factory to examine thoroughly the operating characteristics of each component part as well as to test the entire plant. In addition to the elaborate instrumentation of the complete plant, the Air Preheater Corporation installed an independent thermocouple system for measuring the air and gas temperatures in and out of the regenerator. Fifteen thermocouples were placed in the hot gas stream immediately below the core, and 15 more were placed just above the core for the cooled gas. Two thermocouples were placed to measure the air in and two for the hot air out.

The regenerator performed satisfactorily over a large range of loads, with



GENERAL PLANT ARRANGEMENT

an air-temperature effectiveness slightly higher than the calculated value for any particular load. The air-side pressure drops were somewhat higher than anticipated but the gas-side pressure drops were considerably lower.

An inspection of the surfaces after the tests were completed revealed the surfaces completely clean and free from any deposits.

Review of Optimum Design of Gas-Turbine Regenerators, by D. Aronson, Mem. ASME, Greensburg, Pa. 1951 ASME Annual Meeting paper No. 51—A-107 (mimeographed; to be published in Trans. ASME).

THE fuel consumption of the gas turbine can be significantly reduced by means of a regenerator to preheat the high-pressure air before it enters the combustion chamber. Thus part of the heat which would otherwise be lost in the turbine discharge gas is returned to the cycle. One approach is to use compact surfaces having a relatively large surface area per volume of core. While such designs reduce the volume of the heat exchanger, they call for large frontal areas which result in awkward shapes. In order to overcome this difficulty associated with compact surfaces, a system of heat exchange using a circulated liquid to couple two independent liquid-gas heat exchangers was prepared. Each unit could then be designed readily for large frontal areas and short flow paths, and would be similar in construction to conventional radiators used with liquid-cooled internal-combustion engines.

The other approach to the problem of obtaining the most effective regenerator possible within set limits of cost, weight, volume, or shape is to design for the optimum ratio of surface area for the high-pressure fluid to that for the low-pressure fluid, or for the optimum ratio of flow areas. One method considers the case of finned tubes; another, the case of bare tubes in counterflow exchangers. This paper presents the optimum ratios for plate-fin crossflow and bare-tube crossflow arrangements.

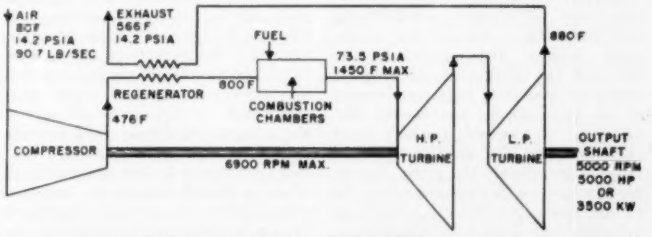
Good design involves both the selection of the most suitable surface and the utilization of that surface most effectively. Several types of heat-transfer surfaces or arrangements are compared and the optimum relationships applicable to each type are discussed.

Design Features of a 5000-Hp Gas Turbine, by Bruce O. Buckland, Mem. ASME, and Donald C. Berkey, Jun. ASME, General Electric Company, Schenectady, N. Y. 1951 ASME Annual Meeting paper No. 51—A-113 (mimeographed; to be published in Trans. ASME).

A 5000-HP, one-compressor, two-turbine, gas-turbine power plant is described, its features are discussed, and its expected capability and economy are given. The first one is expected to be in commercial operation early in 1952.

The plant, which is designed to have a maximum of flexibility in its application, is intermediate in efficiency and complication between a simple one-compressor, one-turbine, nonregenerative power plant and a two-compressor, two-turbine, intercooled and regenerative power plant designed by G.E.

The axial-flow compressor has 14 stages and operates at a pressure ratio of 5.5. The turbine has two stages. The second stage produces the useful load and has a nozzle arranged so that its effective flow area can be varied during operation. The six combustion chambers are expected to operate at 800 F preheat and at 650 F rise. The cylindrically shaped regenerator when used is mounted on end and outdoors. The lube-oil system is similar to that used



SCHEMATIC DIAGRAM OF 5000-HP REGENERATIVE-CYCLE GAS TURBINE

for steam turbines. The plant can be supplied either with a motor-driven or a turbine-driven cranking assembly. The control means for starting and stopping the plant and for controlling the turbine speeds and temperatures during operation is described. The installation requirements such as weights, outline dimensions, and water requirements are given.

The Effect of High-Frequency Sound Waves on an Air-Propane Flame, by Charles J. Kippenhan, Jun. ASME, Washington University, St. Louis, Mo., and H. O. Croft, Mem. ASME, State University of Iowa, Iowa City, Iowa. 1951 ASME Annual Meeting paper No. **51—A-112** (mimeographed).

MEASUREMENTS of normal flame velocity of propane-air mixtures by the "burner method," are described. The experimental burner was so arranged that high-frequency sound could be introduced into the burner and allowed to travel through the gas-mixture column and combustion zone.

Experimental measurements of the normal flame velocity indicate that high-frequency sound waves within the range used have little or no effect on this important parameter. This was verified for flames formed on a burner tube in which the flow Reynolds number was above and below the lower critical limits (turbulent and laminar flames).

Visual observations disclose a change of combustion-zone configuration of sound-influenced flames from the usual "cone" to a flattened bowl shape for laminar flames, and to a suspended violently agitated zone in the case of turbulent flames, both possessing remarkable stability.

Methods of Measuring High Temperatures in Gas Streams, by E. R. Letsch and W. J. King, Mem. ASME, University of California, Los Angeles, Calif. 1951 ASME Annual Meeting paper No. **51—A-143** (mimeographed).

WITH the increased emphasis in recent years on research, development, and production of gas turbines, jet engines, rockets, and similar devices, the need for information on adequate means for measuring high temperatures in gas flow systems has become pronounced. Conventional methods using ordinary unshielded thermocouples are subject to considerable error, due to heat exchange with the surroundings, or to kinetic-energy effects at high gas velocities, or both. At temperatures above 2000 F, thermocouples are apt to be very short-lived, especially in high-speed oxidizing gas streams. In the 3500 F blast from a jet-engine afterburner, special precautions must be taken to prevent the temperature-sensing element from being burned off in a few moments. Considerable difficulty has been experienced in attempting to develop reliable and convenient instruments for such applications.

This paper summarizes the published literature of the subject and the various techniques that have been developed to date. Limitations of these methods are discussed and procedures are recommended for particular conditions.

In general, it is concluded that the state of the art of pyrometry in the range of temperatures and velocities of interest in the gas-turbine and jet-propulsion field is unsatisfactory as regards accuracy, reliability, and availability of adequate standardized instruments. There is a definite need for more evidence as to the merits of the various methods available, before any of them can be recommended or used with confidence, particularly under the more severe conditions. Perhaps new and better methods can be devised.

Wet Compression in an Axial-Flow Compressor, by Shao-Lee Soo, Jun. ASME, Princeton University, Princeton, N. J. 1951 ASME Annual Meeting paper No. **51—A-99** (mimeographed; to be published in Trans. ASME).

THE wet-compression process, in which compression is made of a mixture of finely divided liquor water suspended in the air, was originally proposed by R. V. Kleinschmidt for improving the thermal efficiency and performance of gas-turbine units. It has also been suggested that a simple efficient gas-turbine cycle of high pressure ratio can be carried out with wet compression, and in this cycle no regenerator or intercooler is necessary. This process has not only been considered as useful in marine propulsion, but also for turbojet thrust augmentation.

In previous studies the ideal condition of continuous saturation of air-steam mixture during compression has been assumed. The assumption implies that either the mixture of air and water is very slowly compressed, such that equilibrium is maintained throughout the steps, or the diffusion rate between air and steam is infinitely large. However, considering the fact that each bulk of air is pushed through an axial-flow compressor in the order of a hundredth of a second, with finite diffusion rate, the foregoing assumption tends to give theoretical results which are over-optimistic. This study correlates various factors, such as particle size, design of compressor, etc., to obtain a better approximation to actual conditions, and to organize a theoretical basis for design and test.

From the studies, it was found that:

1 Wet compression is more efficient at high pressure ratios than at low pressure ratios when other conditions (inlet conditions, particle size, and logarithmic rate of compression) are similar.

2 Efficient wet compression requires water particles of size below 20 microns in diam. There is little or no danger of erosion of blades with particles of this order of magnitude.

3 Efficient wet compression requires a relatively slow rotational speed and a low axial velocity and therefore a relatively large machine for a given capacity. With proper design, 100 per cent wet-compression efficiency can actually be obtained.

4 Efficient wet compression requires a compressor specially designed for such a purpose. Ordinary compressors designed for dry air do not work well when this process is adapted. However, tolerable dry compression can be carried out in a compressor designed for wet compression.

5 The wet-compression cycle, using a volatile fuel, is advantageous for aircraft propulsion. In this case the previous statement is not important.

Heat-Transfer and Flow-Friction Characteristics of Some Compact Heat-Exchanger Surfaces, Part 3—Design Data for Five Surfaces, by A. L. London, Mem. ASME, W. M. Kays, Jun. ASME, and D. W. Johnson, Jun. ASME, Stanford University, Stanford, Calif. 1951 ASME Annual Meeting paper No. **51—A-129** (mimeographed; to be published in Trans. ASME).

RECOGNIZING the need for ascertaining and making generally available basic heat-transfer and flow-friction design data for compact heat-transfer surfaces, the USN Bureau of Ships initiated in 1945 a test program at the USN Engineering Experiment Station. This program was supplemented in 1947 when the Office of Naval Research, in cooperation with the Bureaus of Ships and Aeronautics, established a similar project at Stanford University.

This paper presents basic heat-transfer and flow-friction design data for five such surfaces. Three of these are variations of the finned-circular-tube type. The other two are flow inside small rectangular (6:1 aspect ratio) and circular tubes.

In addition to the use of conventional

nondimensional heat-transfer and flow-friction correlations, the various surfaces are compared on a heat-transfer-coefficient versus flow-friction-horsepower basis.

Convective Heat-Transfer and Flow-Friction Behavior of Small Cylindrical Tubes—Circular and Rectangular Cross Sections, by W. M. Kays, Jun. ASME, and A. L. London, Mem. ASME, Stanford University, Stanford, Calif. 1951 ASME Annual Meeting paper No. **51—A-130** (mimeographed; to be published in Trans. ASME).

RECENT heat-transfer and flow-friction test data for gas flow in small circular and rectangular cylindrical tubes, in the laminar, transition, and low-Reynolds-number turbulent-flow régimes, are examined and compared with earlier results.

For circular tubes in laminar flow, the heat-transfer results substantiate previous analytical predictions. In turbulent flow, circular-tube heat transfer is correlated by an empirical nondimensional equation of the same form, but with a somewhat lower coefficient than has been commonly employed in the past. The difference is attributable in part to the use of more recent data on air properties in the reduction of test results to a nondimensional form. The transition region for circular tubes is found to extend from about $N_R \sim 2000$ to $N_R \sim 10{,}000$, and heat-exchanger design in this "dip" region is discussed.

Laminar-flow circular-tube friction factors show an entrance-length effect, similar to that found for heat transfer, and it is demonstrated that the analysis for flow in a single tube can be employed to predict friction factors with acceptable accuracy for flow through a tube bundle even with the sudden change of flow area at the contracted tube-entrance section.

For small circular tubes, as a result of this analysis, recommended design correlations in graphical form are given for the N_R range 500 to 50,000.

The turbulent-flow heat-transfer and friction performance of rectangular tubes is in close agreement with the characteristics for circular tubes. However, there is a marked difference in the laminar and transition behavior, where the aspect ratio of the rectangular cross section is demonstrated to have an important influence. Unlike circular tubes, in the transition-flow régime no dip behavior is evidenced if the aspect ratio of the rectangular section is large. Results reported cover only one aspect ratio, approximately 6:1, and for this geometry no dip exists. To investigate this behavior more completely, results are needed for the aspect-ratio range 1:1 (square section) up to 6:1.

It is concluded that considerable additional work, both analytical and experimental, is needed to ascertain laminar and transition flow-friction and heat-transfer characteristics in rectangular tubes.

Heat Transfer

A Method of Correlating Heat-Transfer Data for Surface Boiling of Liquids, by Warren M. Rohsenow, Jun. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1951 ASME Annual Meeting paper No. **51—A-110** (mimeographed; to be published in Trans. ASME).

A METHOD based on a logical explanation of the mechanism of heat transfer associated with the boiling process is presented for correlating heat-transfer data for nucleate boiling of liquids for the case of pool boiling. The suggested relation is

$$\frac{C_l T_x}{h_{fg}} = C_{sf}\left(\frac{q/A}{\mu_l h_{fg}}\sqrt{\frac{g_c\sigma}{g(\rho_l-\rho_v)}}\right)^{0.33}\left(\frac{C_l\mu_l}{k_l}\right)^{1.7}$$

where the various fluid properties are evaluated at the saturation temperature corresponding to the local pressure and C_{sf} is a function of the particular heating surface-fluid combination.

Heat Transfer and Pressure Drop for Turbulent Flow of Air-Water Mixtures in a Horizontal Pipe, by H. A. Johnson, Mem. ASME, and A. H. Abou-Sabe, Jun. ASME, University of California, Berkeley, Calif. 1951 ASME Annual Meeting paper No. **51—A-111** (mimeographed; to be published in Trans. ASME).

PIPE flow systems with mixtures of vapor and liquid are common in many industrial equipments. More often these systems are for single-component fluids attended by condensation or vaporization due to heat transfer or large pressure drop, i.e., "flashing." Less common are two-phase two-component systems under flow conditions of limited pressure drop and heat transfer such that compressibility, momentum, and phase change effects along the pipe length are negligible.

The static pressure drop and heat transfer for two-phase two-component flow of air and water were measured for flow in a horizontal 15-ft length of 1-in., 16-gage brass tubing. Flow rates include the range of 1000 to 15,000 lb per hr for the water and 0 to 200 lb per hr for the air. Tentative correlations are presented from which prediction of pressure drop and heat transfer may be made under restricted flow conditions.

Heat Transfer and Fluid Friction During Flow Across Banks of Tubes—IV, A Study of the Transition Zone Between Viscous and Turbulent Flow, by O. B. Bergelin, G. A. Brown, and S. C. Doberstein, University of Delaware, Newark, Del. 1951 ASME Annual Meeting paper No. **51—A-109** (mimeographed; to be published in Trans. ASME).

THE experimental results of a long-term research program on flow across tube banks have been extended from the zone of viscous flow through the transition zone and well into the zone of turbulent flow. Pressure drop and rate of heat transfer are reported for the flow of a light oil across five rectangular banks of $^3/_8$-in-diam tubes. Equilateral-triangle, staggered square, and in-line square arrangements on a 1.25 pitch ratio, and equilateral triangle and in-line square arrangements on a 1.50-pitch ratio are discussed. The flow rate of the oil covers a Reynolds-number range of from 25 to 10,000. Heating, cooling, and isothermal tests are reported.

The Design of Heat Exchangers for Minimum Irreversibility, by Frank A. McClintock, Jun. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1951 ASME Annual Meeting paper No. **51—A-108** (mimeographed).

THE application of the concept of irreversibility to the design of heat exchangers appears to be a promising technique. Equations are developed to yield an optimum design for one side of an exchanger with constant temperature difference between the wall and the fluid. Since similar equations would hold for an element of differential length in any heat exchanger, the results are of general interest. Equations developed for one side of a heat exchanger yield a criterion for the optimum type of surface. For an extended-surface heat exchanger each side should be designed in the optimum manner, so this criterion should be valid for each side. When applied to experimental data, the criterion indicates that the higher the surface heat-transfer coefficient, the better the surface, in spite of a higher friction factor. In fact, the best surface reported consists of tubes normal to the direction of flow. The form of the equations is such that cost factors can be incorporated easily.

Further studies might well be made to consider both sides simultaneously when they have a common area, to treat ex-

changers which have a practically constant wall temperature, and to treat crossflow exchangers.

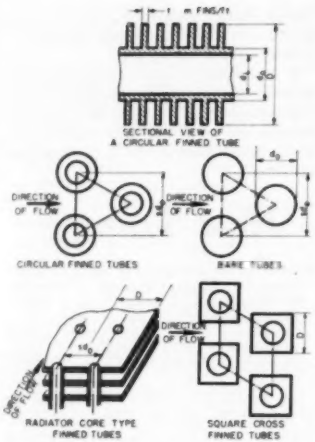
Optimum Crossflow Heat Exchangers, by James T. Fong, Burns and Roe, Inc., New York, N. Y. 1951 ASME Annual Meeting paper No. 51—A-98 (mimeographed).

A SIMPLE mathematical equation for the maximum velocity of the form

$$F^{EX}\sqrt{M\rho\frac{\Delta_c\Delta t_m}{c_p\Delta t_0}}$$

is derived for a gas flowing normal to tube banks of heat exchangers, bare tube or extended surface, used widely for wind-tunnel coolers and forced-draft or induced-draft cooling in areas where air is the cheapest cooling medium. Extending this maximum mass velocity concept, one may also preselect the most economical tubing size for a given duty provided that the characteristics of the tubings are known.

The last part of the paper deals with the optimization of the crossflow heat exchanger so that the annual total cost, consisting of the annual power cost plus the fixed charges or annual amortization of the initial cost of the equipment, is at a minimum. In such an analysis it is found that the (allowed) pressure drop which the process engineer or the manufacturer assumes and specifies as constant is shown to be a variable for the optimum case depending upon $\Delta t_0/\Delta t_m$ and R_t.



SOME SAMPLES OF HEAT-TRANSFER ELEMENTS OF CROSSFLOW HEAT EXCHANGERS

Properties of Metals

Embrittlement of 12 Cr Steels After Exposure to 750 and 900 F, by Merrill A. Scheil, A. O. Smith Corporation, Milwaukee, Wis. 1951 ASME Annual Meeting paper No. 51—A-97 (mimeographed; to be published in Trans. ASME).

THIS paper describes the effect of exposure after 13,500 hr at 750 F and 9000 hr at 900 F on the mechanical properties and notch-impact strength at room temperature of seven unstressed 12 Cr steels and one 9 Cr, 1 Mo steel which may be applied in refinery service at elevated temperatures.

The embrittlement shown after the first year's exposure on seven 12 Cr steels can be predicted on the basis of the chromium equivalent.

The tests represent three conditions of treatment for the alloys: (1) annealed, (2) annealed and cold-worked 13 per cent, and (3) grain-coarsened at 2000 F. The paper describes the first year's exposure to refinery service of an intended six-year program.

Slight changes in the tensile properties are recorded for the cold-worked alloys. Yield-point loss is shown for all cold-worked steels reflecting the stress-relieving action after the 750 and 900 F exposures.

The only change in microstructure observed after 900 F exposure for the 12 Cr alloys is a slight carbide precipitation in the solid solution chromium ferrite. The indications after approximately one year's exposure is that $^1/_2$ per cent molybdenum in either Type 405 or 410 alloy stabilizes the carbide, slows down carbide precipitation at 900 F, and suppresses embrittlement.

Pressure Vessels

The New-Type Code Chart for the Design of Vessels Under External Pressure, by E. O. Bergman, C. F. Braun & Company, Alhambra, Calif. 1951 ASME Annual Meeting paper No. 51—A-137 (mimeographed; to be published in Trans. ASME).

THIS paper presents a new code chart for shells and heads of pressure vessels under external pressure. The chart is especially adaptable to materials like nonferrous metals that have a nonlinear stress-strain curve. The curves for shells consist of two families with a common abscissa scale and different ordinate scales. One family represents the dimensional variables and is the same for all materials. The other family represents the mechanical-property variables of a given material at different temperatures. Each curve is constructed from a stress-strain diagram of the material at the temperature it represents. A "headline" curve provides for the design of hemispherical heads.

The Stresses in a Pressure Vessel With a Flathead Closure, by G. W. Watts, Fellow ASME, and H. A. Lang, Mem. ASME, Standard Oil Company of Indiana, Chicago, Ill. 1951 ASME Annual Meeting paper No. 51—A-146 (mimeographed; to be published in Trans. ASME).

THIS paper presents the results of computations for determining the stresses in a cylindrical pressure vessel with a flathead closure. The accurate bending theory of shells is used to evaluate the local bending stresses in the neighborhood of the junction of the flathead and the cylindrical body. Tables show the magnitudes of the shear stress, the circumferential stress, and the axial stress as multiples of $pd/2t$. The locations where these stresses are critical are also determined. Curves are given showing the maximum stresses as functions of the diameter-thickness ratio of the shell and of the thickness ratio of head to shell body. The range of calculation includes most vessel sizes encountered in practice.

Tables of influence numbers for the cylinder and the flathead are presented. These tables can be utilized in problems in which other elastic structures are attached to either member. The paper includes a discussion of the mathematical procedure.

A Procedure for Determining the Allowable Out-of-Roundness for Vessels Under External Pressure, by Marshall Holt, Mem. ASME, Aluminum Research Laboratories, New Kensington, Pa. 1951 ASME Annual Meeting paper No. 51—A-136 (mimeographed; to be published in Trans. ASME).

ALTHOUGH the allowable working pressures for vessels under external pressure are usually computed by means of a theory that assumes mathematical perfection of form, it is practically impossible to fabricate such perfect vessels. It is therefore expedient that a certain degree of imperfection be tolerated in the construction of commercial pressure vessels. This situation is recognized by the ASME Boiler Construction Code in that rules are given for determining the allowable out-of-roundness.

The present rules and chart in the Boiler Construction Code were developed

by the Special Research Committee on the Strength of Vessels Under External Pressure. They were intended for use with carbon and low-alloy steels. The problem of allowable out-of-roundness is revived by the extension of the Code to include nonferrous materials and high-alloy steels. In developing new charts for the new materials it would seem desirable to follow a procedure that is applicable to all materials and needs only a single factor which is developed from the mechanical properties of the particular material under consideration.

The procedure developed in this paper is based on the theory of thin shells developed by Dr. R. G. Sturm in "A Study of the Collapsing Pressure of Thin-Walled Cylinders," Bulletin No. 329, University of Illinois, Engineering Experiment Station. The formula for determining the allowable out-of-roundness contains two factors, one based on the proportions of the shell, and the other based on the properties of the material as measured by the allowable design stress. The procedure is applicable to elevated as well as to room temperatures.

Oil and Gas Power

Summary of Investigation of Two-Stroke-Cycle Gas-Generator Aircraft Engine, by B. I. Sather, F. R. Schuricht, and A. E. Biermann, Lewis Flight Propulsion Laboratory, Cleveland, Ohio. 1951 ASME Annual Meeting paper No. 51—A-131 (mimeographed; to be published in Trans. ASME).

AN investigation of a two-stroke-cycle, gas-generator-type of aircraft engine is described. A theoretical analysis of the performance of the ideal gas-generator engine, an analysis of methods of achieving ideal performance when the engine components are fixed, and some experimental results are included. The experimental work was performed on the reciprocating component only and consisted of data obtained from three types of two-stroke-cycle single-cylinder test engines.

Information presented in previously published NACA reports on the gas-generator engine together with some unpublished work on component requirements and gas-generator evaluation are summarized. Certain practical problems connected with the gas-generator type of engine are also discussed.

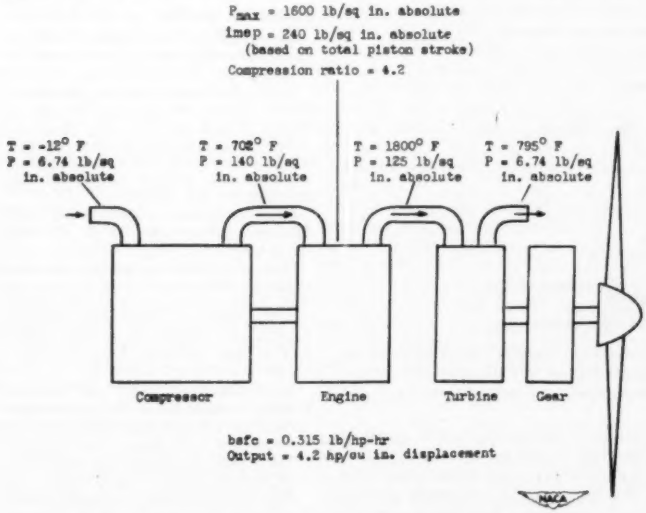
The analysis indicates that the two-stroke-cycle gas-generator engine promises an aircraft power plant of low specific weight combined with low specific fuel consumption. At an altitude of 20,000 ft, the specific fuel consumption was 0.32 lb per bhp-hr and the cruising specific weight was 0.84 lb per hp without the propeller.

Performance potentialities of this type of engine are not limited by knock or preignition over the range of the compression ratios experimentally evaluated.

Moderate inefficiencies in the reciprocating component and the compressor result in only slight losses in the over-all efficiency of the gas-generator engine but produce relatively greater losses in specific output.

It was found possible to operate a two-stroke-cycle cylinder at the pressure and temperature levels required for the gas-generator engine.

Mechanical functioning of the piston engine under gas-generator operating conditions was generally satisfactory.


P_{max} = 1600 lb/sq in. absolute
imep = 240 lb/sq in. absolute
(based on total piston stroke)
Compression ratio = 4.2
T = -12° F
P = 6.74 lb/sq in. absolute
T = 702° F
P = 140 lb/sq in. absolute
T = 1800° F
P = 125 lb/sq in. absolute
T = 795° F
P = 6.74 lb/sq in. absolute
Compressor
Engine
Turbine
Gear
bsfc = 0.315 lb/hp-hr
Output = 4.2 hp/cu in. displacement
NACA

TYPICAL GAS-GENERATOR PRESSURES AND TEMPERATURES AT 20,000 FT

Research in Exhaust Manifolds, by P. H. Schweitzer, Mem. ASME, Pennsylvania State College, State College, Pa. 1951 ASME Annual Meeting paper No. 51—A-132 (mimeographed; to be published in Trans. ASME).

THE exhaust system of an internal-combustion engine, particularly of the two-stroke-cycle type, has an important influence on its performance.

Exhaust interference between cylinders results in poor scavenging and overheating with loss of power, efficiency, and engine life.

The most important factor in exhaust-manifold design is its geometric configuration. Size and tuning, controlled by the length of tail pipe, have some influence on multicylinder performance and predominant effect on single-cylinder performance.

Exhaust manifolds can generally be classified into three groups: (1) back-pressure manifolds, (2) aspirator manifolds, and (3) neutral manifolds. Back-pressure manifolds create a back pressure in the branch pipes which tends to propagate through the cylinder into the air box, opposing blower delivery and scavenging. Subjected to the "suction test" on the air model, with closed scavenge air admission but the cylinder being charged with high-pressure air between scavenging periods, the back-pressure manifold shows positive pressure in the airbox.

Aspirator manifolds create a vacuum in the branch pipes which tends to propagate through the cylinder into the airbox, reducing counter pressure on the blower and aiding scavenge flow. Subjected to suction test the aspirator manifold shows vacuum in the airbox.

Neutral manifolds create neither back pressure nor vacuum. Subjected to suction tests the airbox shows substantially atmospheric pressure.

The classification of a manifold is mostly determined by its geometric shape and the rotative speed. Its size, scavenge pressure, exhaust release pressure, firing order, and other operating

conditions have little or no influence on it. A back-pressure manifold at low speed can turn into an aspirator manifold at high speed, especially at favorable firing order. Typical aspirator shapes continue to aspirate (or stay practically neutral) down to very low speeds and are little affected by the firing order.

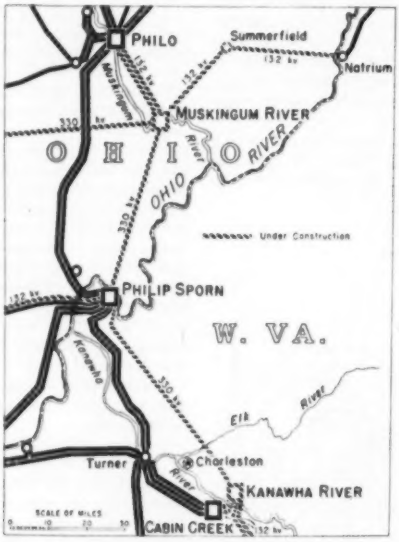
Steam Power Generation

The Development and Implementation of a Generation Program on the American Gas and Electric Company System, I—System Fundamentals, by Philip Sporn, Fellow ASME, American Gas & Electric Service Corporation, New York, N. Y. 1951 ASME Annual Meeting paper No. **51—A-115** (mimeographed; to be published in Trans. ASME).

THE paper discusses the fundamentals considered in the development of an optimum power supply for the American Gas and Electric Company System. The recent rapid growth in electric power demand on this system has required the construction of five new generating plants in less than seven years; emphasis in this paper is on the two most recent additions, Kanawha River Plant of Appalachian Electric Power Company and Muskingum River Plant of The Ohio Power Company. The paper describes the American Gas and Electric Company System, a review of the plant sites, and the reasons for selecting these sites, as well as considerations involved in selecting equipment of very large unit size, all of which has been projected in terms of mass production of electric power, with strong emphasis placed on plant location, transmission, and fuel supply to provide a reliable system power supply at the lowest possible cost.

The Development and Implementation of a Generation Program on the American Gas and Electric Company System, II—Fuel Supply, by Philip Sporn, Fellow ASME, and H. A. Kammer, American Gas and Electric Service Corporation, New York, N. Y. 1951 ASME Annual Meeting paper No. **51—A-116** (mimeographed; to be published in Trans. ASME).

THE engineering and economics of fuel supply for the generating plants of the American Gas and Electric Company System are discussed, and in particular the fuel supply for two new plants—Kanawha River and Muskingum River. The importance of adequately planning fuel supply for a large power system is stressed, and the fundamental considerations of adequacy of supply, reliability, characteristics of supply, coal storage, and transportation are discussed with reference to the System characteristics, and with special emphasis on the development of the fuel supply.



MAP OF A PORTION OF THE AMERICAN GAS AND ELECTRIC COMPANY SYSTEM SHOWING THE CLOSE GEOGRAPHIC PROXIMITY AND TRANSMISSION TIES OF FIVE MAJOR PLANTS, PHILO, MUSKINGUM RIVER, PHILIP SPORN, CABIN CREEK, AND KANAWHA RIVER

The Development and Implementation of a Generation Program on the American Gas and Electric Company System, III—200,000 Kw, 2000 Psi, 1050 F-1050 F—An Advance in the Economics of Integrated Power System Generation, by Philip Sporn, Fellow ASME, and S. N. Fiala, Mem. ASME, American Gas and Electric Service Corporation, New York, N. Y. 1951 ASME Annual Meeting paper No. **51—A-117** (mimeographed).

THE paper discusses the steam-electric generating units being installed at the Kanawha River Plant and Muskingum River Plant. Reasons for the selection of unusually large single-boiler single-turbine sets are presented in terms of the over-all generating picture of the AG&E System. Basic considerations in the selection of component equipment for these units are developed, as well as the means by which these components have been combined to accomplish an economical arrangement for mass generation of power for the System.

ASME Transactions for February, 1952

THE February, 1952, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

The Creep and Stress-Rupture Testing of Steam-Boiler Materials, by J. B. Romer and H. D. Newell. (50—A-129)

On the Automatic Control of Generalized Passive Systems, by Kun Li Chien, J. A. Hrones, and J. B. Reswick. (51—SA-29)

Supervisory Instruments for Power-Generating Equipment—Application and Interpretation of Records, by E. Y. Stewart and J. H. Reynolds, Jr. (51—SA-49)

Field Inspection of Boiler Tubes With Ultrasonic Reflectoscope, by J. A. Tash. (51—SA-48)

Methods of Reducing Dust Emission From a Spreader-Stoker-Fired Boiler Furnace, by W. C. Holton and R. B. Engdahl. (51—SA-20)

A New Method for Determining the Static Temperature of High-Velocity Gas Streams, by J. A. Clark and W. M. Rohsenow. (51—SA-33)

Some Aspects of Design and Economic Problems Involved in Safe Disposal of Inflammable Vapors From Safety Relief Valves, by S. Chesler and B. W. Jesser. (51—SA-18)

The Mamba Engines in the Apollo Aircraft, by B. H. Slatter. (51—SA-14)

An Instantaneous and Continuous Sodium-Line Reversal Pyrometer, by M. M. El Wakil, P. S. Myers, and O. A. Uyehara. (50—A-94)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Turbojet Aircraft—the Jetliner

COMMENT BY KARL H. LARSSON[1]

After a statement on the objectives of air transportation—which is a subject that could well require a paper of its own—the author stresses, quite rightly, the fact that the development of new aircraft begins with the choice of engine type.[2]

Because of the tremendous costs of developing a new-type power plant, it is only in connection with military needs that the money is forthcoming for such purposes, and this will be the case also in regard to turbine engines.

The author points out that this situation has favored the straight jet engine and that the turboprop type is at a disadvantage. This may be true at the moment on this continent, but does not seem to be a valid reason for not considering the turboprop-type engine along with the straight jet, all the more as any development of the turbine engine as such will be of equal benefit to both types.

There is another problem, however, in connection with the adoption of military engines for civil use, that will bear discussion.

Experience, so far, indicates that military engines with some modifications have been adapted successfully to commercial operation. The military demand is for maximum performance rather than long life or maximum economy. The commercial application stresses the dependability and the maximum economy and long life.

With the piston engine this adaptation could easily be accomplished simply by "derating" the military engine, that is, by cutting down the power without any detrimental effect on fuel economy. However, owing to the very nature of the turbine engine, a similar method does not seem feasible, because the maximum fuel economy is obtained at the maximum power and maximum operating temperature which, on the other hand, tends to shorten the life of the engine. This seems to indicate that the adaptation of military jet engines to commercial use will represent a bigger problem than with piston engines.

In discussing the cruising speeds over different stage distances obtained by piston-engine aircraft, as compared to turbine aircraft, the author concludes that the straight jet aircraft is the most suitable type from 300–400 miles up to 3000 or 4000 miles. Experts seem to agree that there is definitely a medium-range bracket from about 300–1000 miles where the turboprop type has an advantage over the others, and it would have been interesting if the author had enlarged a little more on this subject and the reason for his viewpoints, especially as the Jetliner has been designed to operate in this range bracket.

Discussing the aerodynamic aspects, the author claims that straight jet power has the advantage of more flexibility of cruising speed in operation than the propeller-driven types. This is surprising! It may be that a jet plane is capable of wider speed range through variation in altitude, but it is equally true that in order to operate at maximum fuel economy a much stricter procedure must be adhered to in the case of a jet plane than with a propeller-driven aircraft. Even small deviations from such operating procedures are paid for heavily in increased fuel consumption, larger fuel reserves, smaller pay load and higher cost per ton-mile. This is stressed by the author himself in the latter part of the paper.

In discussing the practical problems connected with the operation of a turbojet aircraft, the author states that in the trial flights the Jetliner has proved conclusively that take-off, approach, or landing characteristics do not represent any specific problems and that the Jetliner can be operated in and out of airports, the same way as piston-powered aircraft.

In a report on the trial operation of the B-45 in the United States, the pilots expressed quite some concern about the long landing run without the help of reversed thrust from propellers. "Although the final approach air speed of the B-45 is only slightly higher than that of such airplanes as the B-29, there is a distressing lack of propeller drag for initially slowing down the jet airplane. Bringing the airplane to a stop with brakes alone is feasible on a wet macadam runway. The more unfavorable braking action on ice or snow renders operation on 5000-ft runways impossible, and even makes operation on wet concrete questionable. Only runways of extreme length can be used for snow or iced runway operation." They do not believe that any type of wheel brake can bring the jet up to the controllability level of present transport airplanes, until reversed thrust is added to the jet.

It would be interesting to have the author's opinion on the Jetliner characteristics in this respect.

Finally, the author outlines the operating procedure and technique necessary to follow in order to obtain the optimum fuel economy—among other things it involves climbing to the highest altitude that can be reached at the given gross weight. This altitude for the Jetliner ranges from 30,000 to 35,000 ft. The author discusses a typical operation over a 500-mile range and concludes that the jet aircraft is competitive with the other types while having the increased advantage of higher speed and comfort. This eliminates the turboprop without further discussion.

Most people agree that turbine-driven aircraft, both turboprop and turbojet types, eventually are going to replace our present piston-engine aircraft. But the question is only: in which type of operation and at what time?

The writer agrees with the author that the piston engine is probably going to be with us for some considerable time on short-haul applications, and generally as a standby during the transition period, which may be another 10 years.

It is believed to be equally certain that turboprop aircraft have a mission to fulfill on medium-range operation and long-range coach-type traffic at speeds in the 300 to 450-mph bracket.

As for the pure jet, it no doubt will be the supreme power plant for long-range (more than 1000 miles) operation, at speeds of 450–600 mph where full advantage can be taken of its potential qualities. However, this will be economi-

[1] Canadaire, Ltd., Montreal, Canada.

[2] "Turbojet Aircraft, With Special Reference to the Jetliner," by E. H. Atkin, MECHANICAL ENGINEERING, vol. 73, October, 1951, pp. 791–794 and 798.

cally feasible only when new types of jet engines with improved fuel economy and longer life are made available commercially.

COMMENT BY R. L. McBRIEN[3]

From the airline standpoint, Fig. 1 of the paper would be more significant if predicated on equal pay loads as well as equal ranges and speeds. Charts plotted on the basis of equal pay loads would give a clearer idea of the size airplane required by the different power-plant types to perform a given transport job. We do not understand from Fig. 1 why the weight chargeable to crew and equipment should be greater for the piston-engined airplane than for the turbine-powered airplanes. Nor can we reconcile the comparative weights charged in Fig. 1 to power plants, reserve fuel, and pay load with recent data to which we have had access. The jet airplane is represented to have a far wider margin of superiority on a weight-analysis basis than we have seen depicted in other studies.

The statement that improvements in the economy of the gas turbine bring greater dividends in the case of the jet than in the case of the turboprop transport does not appear to be supported adequately. Turbojets have been installed on some large aircraft to augment the cruising power available from reciprocating engines, primarily because of the availability of the jets. Turboprops, if available, might have been more economical from an operating consideration.

In regard to operational flexibility being of value in maintaining tight airline schedules, we believe the turboprop will show to better advantage than the jet transport. Any direct comparison of aircraft flexibility should be based upon the same speed, as long as speeds less than 500 mph are considered. The jet engine suffers greater power loss at high air temperatures, and its specific fuel consumption changes more with altitude variations. Since the jet fuel consumption necessitates cruising at high altitudes where head winds are greater, schedule maintenance is expected to be more of a problem than with turboprops.

In addition, jets are expected to require more pay-load sacrifice when conditions are adverse—either to assure hot-day take-off performance, or because more fuel is required to combat the stronger head winds at the best cruising altitude.

We concur with the author that a propeller always complicates a power-plant installation and introduces other undesirable features. Propellers do provide some advantages, however, that must be given up when jets are used alone. Required runway lengths are shorter with propellers, for instance. The complication of dive brakes also may be introduced without propellers. We do not believe that the economies of jet engines have yet reached the point where they make propeller power plants obsolescent over flight segments shorter than 700 miles.

[3] United Air Lines, Chicago, Ill.

COMMENT BY H. L. SHAMBACH[4]

The author appears to feel that turboprops are rather unsatisfactory. The writer is curious about the basis for his Fig. 1 showing such high power-plant weight for a 450-mph turboprop, as well as quite different crew and equipment weights for the three types of aircraft.

Fig. 4 indicates that for short ranges a relatively large increase in cruising speed seems to pay little dividend in increased block speed. For instance, at a 500-mile range, an increase from 400 to 500 mph in cruising speed, or 25 per cent, gives an increase of only about 8 per cent in block speed. This seems rather low. The added cruising speed would show up to better advantage over longer-range flights, and might be rather hard to sell for short hops. Fig. 14 indicates that fuel economy also would be improved on longer flights. Less than one half the fuel is used in cruising more than three quarters of the 500-mile distance. On a longer flight a smaller proportion of the fuel would be required just for climb and descent. Is A. V. Roe considering development of a longer-range jet transport?

The high pressurization required by transports operating at such altitudes as 30,000 ft is causing no little concern. As the author mentions, the stored energy in a highly pressurized fuselage is considerable. Even at the lower pressures in current transports, several window failures have occurred, with undesirable results. In fact, serious consideration has been given to eliminating windows from highly pressurized transport aircraft. How has this window problem been handled in the Jetliner? Just one occurrence of explosive decompression might give jet transports considerable adverse publicity.

Maintaining scheduled operation in instrument weather brings up several considerations. Pilots who have flown jet aircraft find precision-instrument flying relatively difficult at high speed. Small deviations in altitude, heading, and the like, can move the plane out of position quite rapidly. The use of dive brakes to hold down speed during rapid descent and instrument maneuvering has been suggested. Pilots have reported difficulty in attempting to follow an ILS approach path in jet aircraft, and find considerable "mushing" if required to apply power for a pull-up without landing after the approach. Judging from Fig. 14 of the paper, the plane is apparently committed to land at a given airport once descent is made to an altitude for an instrument approach to a landing. This conclusion is drawn from the large amount of fuel required for climbing back to a high altitude, and the very high fuel consumption for any cruising done at low altitude. This could cause setting of higher weather minimums for jet aircraft, both for the destination airport and the alternate.

Even after the plane is on the ground, stopping it well may require considerable runway length. The same low drag mentioned by the author, which assists a jet plane in getting off the ground in spite of relatively low power developed during take-off, makes stopping difficult. There is no air resistance from even idling windmilling propellers, much less from reverse-pitch power. Thus the jet plane is quite dependent upon its wheel brakes. On a dry runway with good traction, 5000–6000 ft of runway length can be ample for slowing the plane to taxiing speed after getting it on the ground. However, under instrument conditions, runways are likely to be far from ideal. On just wet runways, more than one piston-engine transport has gone through the fence, even with idling propellers, but poor braking action. Snow, ice, or slush would make the situation worse. Some pilots feel that 10,000 ft of runway under such conditions would be none too much for a jet transport. Thus the jet might be limited to use of fairly large fields for regular scheduled operations, and if, as stated, concrete runways are required this might reduce further the number of fields available for use.

As is pointed out by the author, the trend is toward ever-higher speeds. This is essential in military aircraft, and has spurred development and use of the jet engine. This power plant is also bound to be used in commercial transports where economically practicable, and the Jetliner development aids progress in that direction.

[4] Aviation Division, General Electric Company, Schenectady, N. Y.

AUTHOR'S CLOSURE

The differences between the advance copy and the published version of the paper make it somewhat difficult to reply to the comments consistently.

In reference to Mr. Larsson's comments, it is entirely agreed that the immediate nonavailability of suitable turboprop engines is no reason for not examining the relative merits of aircraft powered with this type of power plant; it is agreed that improvements which can be applied to the turbojet can equally well be applied to the turboprop as far as the engine itself is concerned. This, however, does not take into account the gearbox and propeller complications in the case of the turboprop. It should be stated that in making such a comparison equal improvements were assumed in fuel consumption for both types of engine and the corresponding effects on operating costs. It was found at that time that the improvement in operating costs for the turbojet was disproportionately greater owing to the much greater fuel consumption of the turbojet which hence contributes much more to the operating costs.

As to the question of the adaptation of turbine engines to commercial operation, it is true that derating is not always an acceptable method of obtaining longer life, as has been the case of the piston engine. Nevertheless, it does appear from experience obtained with the turbojet that competitively long life can be achieved. Investigation of one engine, however, did indicate that derating would be acceptable.

Passing now to Mr. Larsson's point regarding flexibility of operation, it was not intended to imply that the jet aircraft is as flexible in operation from an altitude point of view as the other types, as this is manifestly untrue. The point which the author wished to make was that the turbojet is sensitive to temperature effects as well as to altitude, and, therefore, that it pays to build a jet transport with excess power for climb and cruise to give a margin so that variations in temperature can be compensated without having to sacrifice ground cruising speed or altitude. This, therefore, is in no sense claimed as an advantage but as a design feature required in the jet transport to make up for its otherwise tight operating conditions.

The low drag of the jet transport is undoubtedly a disadvantage under landing conditions where the surface friction on the runway has been reduced by ice. However, in all the conditions under which it has been found necessary to land the Jetliner up to date, very normal landing runs have proved adequate. It would appear that the high wing loadings associated with some of the older jet aircraft have contributed to the difficulty of landing within reasonable distances.

In reference to Mr. McBrien's comments with regard to the weight breakdown of the various types, it is regretted that the chart which was originally published with the advance draft was incorrect. This has now been amended.

Mr. McBrien's comments with regard to flexibility of operation and temperature effect have been covered in my reply to Mr. Larsson. There is no doubt that additional power is required in order to compensate for the sensitivity of the jet transport to temperature and altitude effects and to enable the tighter schedules which are now being asked for to be met.

With regard to the comments by Mr. Shambach, here again my reply to Mr. McBrien's comments covers the question of weights. It is agreed that extra cruising speed pays on the longer stage lengths, as it has a greater effect on block speed than is the case with the shorter stages.

With regard to the problems and dangers of pressurization at high altitudes, it should be stated that the Jetliner was originally designed for 30,000 ft which was felt to be pretty well the maximum operating height which could be considered for the time being without running into the much more hazardous conditions higher up involving the development of additional safety equipment. The general approach to the problem as far as our company is concerned has been the assumption that the fuselage must be just as safe from a structural point of view as far as pressurization is concerned as the mainplane. In other words, there should be no more chance of pressure failure due to the structure than of the mainplane breaking off. Having started on this basis then sufficient duplication must be introduced into the pressurization system to insure a high standard of reliability.

The difficulties of high-speed high-altitude navigation are undoubtedly very real and will require the development of special techniques and equipment, and no doubt all jet aircraft which fly close to the drag rise will have to be fitted with dive brakes which provide both drag and dive recovery pitching moment.

It has been assumed that a higher standard of weather prediction will have to be achieved in order to avoid the wastage of fuel involved in climbing up again, having descended to have a look at the airdrome. Mr. Shambach's comments on braking characteristics and runway lengths certainly apply to iced up conditions and no doubt for some time to come the jet transport will have to be confined to the larger fields and regular scheduled operation.

In conclusion the writer greatly appreciates the discussion which has arisen out of the paper and would like to thank the commentors for their contributions.

E. H. ATKIN.[5]

[5] Technical Director, A. V. Roe Canada, Ltd., Toronto, Ont., Canada.

Transports—the "Comet"

COMMENT BY KARL H. LARSSON[6]

There is not much to add to this excellent presentation of both technical and economical aspects of CPA's contemplated operation with de Havilland "Comets." The whole paper[7] breathes confidence, both in the manufacturer of the aircraft and in the aircraft itself. At times this confidence borders on optimism—for example, when the author does not "anticipate major operational problems of any magnitude following delivery of our aircraft. Most of these problems will have been foreseen and analyzed and the answer to them will have been incorporated into the equipment."

This sounds a little like wishful thinking, especially in the light of cold facts of past aviation history.

So far, the writer has not heard of a single prototype that has not given considerable trouble, and the worst part of it is that the magnitude of these troubles seems to have increased in recent years, rather than the opposite.

It will be admitted that de Havilland has made a wonderful start on its Comet program, having two prototypes out flying on service tests years ahead of the inauguration of passenger service. Owing to this conscientious preparatory program, it is reasonable to assume that the Comet will have fewer "bugs" than some other conventional airplanes which have been introduced in recent years.

In regard to the operational problems, the author is, of course, on his own ground when discussing these.

We are all acquainted with the special problems that the jet aircraft poses in regard to reserve fuel for stand-off, and so forth, and therefore the writer is impressed with the author's plans to operate the Comet over the North

[6] Canadaire, Ltd., Montreal, Canada.

[7] "Turbojet Transports, With Special Reference to the Comet," by W. G. Townley, MECHANICAL ENGINEERING, vol. 73, October, 1951, pp. 787–791.

Pacific route, including stops at places like Anchorage and the Aleutians—an area which is known to be notorious for bad weather!

There is another thing about over-water operation with jet aircraft on which the author touches, but, unfortunately, does not elaborate. Reference to the engine-failure case en route. The jet-aircraft characteristics are such that fuel consumption becomes exorbitant unless it is operated at the so-called "cruise ceiling" with all engines running. Thus, when one engine fails, the aircraft is bound to lose altitude in the order of 10,000 ft, depending upon the gross weight. At this lower altitude the speed will be lower and the specific fuel consumption higher, both contributing to a deterioration of miles per pound of as much as 14 per cent, as the author himself rightly points out.

He suggests that this makes necessary "precise en-route control," but it is hard to see how one can meet such an emergency other than by carrying an extra amount of reserve fuel for this purpose. If so, this is going to be detrimental to the pay load and economy of operation—unless the "engine-failure case is thrown in together with other emergency contingencies, such as navigational errors, diversion to alternate, and the like, assuming that they do not all happen on the same flight." This, however, sounds a little optimistic!

Finally, in regard to the economic considerations, again the author is confident that the Comet through its inherent high productivity can offset the higher cost per hour and, therefore, achieve the same economic result as our present piston-engine aircraft or better.

It is true that the high speed pays back in lower operating cost, but with the present set of figures that are available for the Comet we cannot reconstruct such a favorable comparison, as shown in Fig. 5 of the paper. The writer is inclined to think that the two curves should rather be reversed—the upper one being the Comet cost and the lower one a typical cost for our present four-engined aircraft on long-range operation.

De Havilland has indicated a direct operating cost for the Comet of 17–18 cents per short-ton-mile at a speed of 435 mph and over a 2000-mile stage distance (SBAC method). Calculated on the same basis, we find the corresponding figure for a well-known piston-engine aircraft to be 15.4 cents per ton-mile at 268 mph, and in United States domestic operation the direct operating cost for the same type during 1950 was only 12 cents per ton-mile at 250 mph.

To conclude, the writer again would congratulate the author on his excellent review of all the factors that have to be considered in planning an operation with commercial jet transport. His viewpoints are very well taken, and quite a few interesting aspects have been brought out, some of which have not received sufficient attention before.

While most of the technical and operational problems might be mastered by a well-run organization, it would seem that the inherent operating economics of the Comet in the version discussed have not yet been brought to the point where it can compete with our present types of aircraft.

In any case, it takes knowledge and courage to enter into this new era of aviation enterprise and CPA and the author seem to have both. Without these qualities we would have no progress in aviation!

COMMENT BY C. G. TALBOT[8]

The impression gained from studying this excellent paper is that thorough consideration has been given to the many complex problems in applying the Comet to the Vancouver–Tokyo route. The placing of a new aircraft in scheduled service is a ponderous undertaking, as experiences in the United States following the war will verify. The operation of a jet airliner, even though it lives up to the promises, including simplicity, of the sales department, offers many challenging new problems. However, the outstanding performance, greatly enhanced passenger comfort—and it must be acknowledged—aircraft simplicity should make this operation most attractive. Some specific comments are offered in the following paragraphs.

It is gratifying to learn that a commercial operator is giving consideration to the use of forward-scanning radar as a means of detecting adverse weather conditions. Some time ago, American Airlines, sponsored by the Navy Bureau of Aeronautics, investigated this possibility. The results were most encouraging. It would seem that avoidance of hail and severe turbulence would be even more mandatory for high-speed aircraft. The possibilities of using radar as a navigation instrument also should not be overlooked.

The most critical operating problem, it would seem, may be in stopping the aircraft on slippery runways. It is most regrettable that some practical means of reverse thrust has not been developed for jet aircraft. True, braking equipment, including antiskid devices, has been highly developed, but the pilot is still entirely dependent upon only one means of stopping his aircraft.

In regard to ground power supply, our experience has indicated that ample capacity must be provided to eliminate the possibility of hot starts. The gas turbine must be brought up to a speed from which good accelerations can be made prior to firing, or a hot start and slow acceleration probably will result. Engine life can be reduced seriously by hot starts.

Finally, the original design philosophy mentioned, that..."the window installation, for example, should be relatively as strong as the wing spar in that neither should fail under any foreseeable operation condition," is very sound. We endorse completely this approach to a serious problem, particularly in light of the experience of one of our crews during a canopy failure in a B-45 at 35,000 ft. Fortunately, the incident had a happy ending but underlined the absolute necessity of using materials and design features such that loss of pressure cannot result.

It will be most interesting to watch this operation and we extend our best wishes for success.

CLOSURE

Mr. Larsson has made some pertinent observations; however, we will have to let experience provide the final answers. Our optimism is well placed since information at hand indicates that very few "bugs" have occurred during the several hundred hours of development flying. This information has been supplied by BOAC who are doing a large portion of the development flying under contract to the British Ministry of Supply.

We wish to amend the prepared speech by stating that we now intend to operate the Comet (Ghost-powered) on our South Pacific route from Sydney, Australia, to Honolulu, Hawaiian Islands, where the stage lengths and weather are ideal. This change was made with reluctance after serious study.

The method of cruise control in the "engine-out" case is being developed by de Havilland, with the aid of BOAC. It is difficult to comment briefly on this subject—suffice to say that we are confident that this condition can be easily met. On one of the development flights this case occurred and the scheduled arrival was delayed ten minutes; the fuel reserves upon arrival were within tolerance.

The economic considerations were admittedly difficult to evaluate and remain

[8] Flight Test Division, General Engineering Laboratory, General Electric Company, Schenectady, N. Y.

largely a matter of opinion. As Mr. Townley pointed out, we hope to break even during the first year, and his break-even point was compared to that of our Canadaire Four equipment which has an operating cost per ton-mile greater than the comparative figures quoted by Mr. Larsson.

We are pleased to see that Mr. Talbot believes in the use of forward-scanning radar. It has been a disappointment to us that adequate equipment will not be ready upon delivery of the aircraft. We intend to install this radar equipment as soon as reliable and proved units are available.

The problem of stopping on slippery runways is one that will bear watching. Our experience indicates that the braking capacity is more than adequate for wet runways and this has been confirmed by our director of Overseas Operations who has flown the Comet under adverse conditions.

I. A. GRAY.[9]

[9] Assistant to the President, Canadian Pacific Air Lines, Ltd., Vancouver, AMF, B. C., Canada.

Problems in Storing and Handling Pulverized Materials

COMMENT BY E. A. DAVIS[10] AND ROLFE POTTBERG[11]

There is no doubt that a serious need exists for a more basic approach to the problem of the flow of materials from bins. The writers' acquaintance with the problem arises through their connection with the development of another means for facilitating bin discharge in addition to those mentioned in this paper.[12] We refer to a device invented and used by the metallurgist, U. C. Tainton, which is now manufactured and sold by the senior writer's company.[13]

Specifically, the device consists of inflatable rubber panels, each fastened at the edges to metal plates. These are mounted, rubber face outward on the interior bin surfaces adjacent to zones where blocking has been found to occur. Air, controlled by a special valving device, is piped through the hopper walls and a hole in the metal plate to accomplish a slow inflation and deflation of the rubber through amplitudes up to 18 in. Naturally, a very large displacement force may thus be gently applied with low unit air pressures.

Generally speaking, the method represents a means of applying high-volume displacement forces at low rates, as distinguished from the small-amplitude, high-frequency agitation provided by vibrator-type devices.

The paper encouraged us to arrange a variety of materials according to what appeared to be one acceptable rheological basis; to see how much correspondence it would show between theory and practice. While the table obviously represents an arbitrary classification of materials, and is certainly no more than a superficial approach, it does illustrate, we believe, that further and sounder thinking along these lines can lead to practical, useful conclusions. In the following tabulation of material classifications a brief discussion is given of the anticipated performance of three basic types of bin-discharge devices. These are (1) vibrators, (2) aerators, (3) large-amplitude-displacement (PneuBin) pancls.

1 *Single-Phase Systems* (dry solid particles). Most of the solid particles are large enough to be relatively unaffected by a gaseous (air) environment.

Type A—Dry granular materials such as coal, grains, crushed stone, gravel, sands, and so forth.

Theory: Once relative interparticle movement is initiated, substituting kinetic for static friction, these materials exhibit fluid characteristics during unconstricted flow, preventing re-establishment of static interparticle friction coefficients. However, the low average rate of descent of any given section of material (especially in the downwardly constricting hopper section) in a discharging bin permits re-establishment of self-supporting compression zones in vertical (arching) or horizontal (funnelling) planes, which must be overcome by re-establishing interparticle movement.

Conclusion: Vibration (small-amplitude, high-frequency) or displacement (large-amplitude, low-frequency) devices should be equally effective, unless overriding considerations (binconstruction material, explosion hazard) prevail. Evidently concrete or wooden bins cannot or should not be vibrated. Aeration at higher pressures may be effective in smaller-particle-size ranges of this class.

Type B—Light interlocking particles such as wood fibers, granular plastic resins, cereal flakes, fibrous materials, soap flakes, ground cork, and so forth.

Theory: Low bulk density, combined with a high degree of resilience, would be expected to make it difficult to transmit small-amplitude movements for any distance through such materials. In addition, relative interparticle movement is more difficult to initiate, owing to the higher friction coefficients.

Conclusion: Large-volume-displacement devices would be expected to be most effective in this case, when so positioned as to agitate or "fluff up" rather than merely to compress. Aeration would be expected to be effective in the smaller-particle-size ranges, provided that the static head of material and resultant densification is not sufficient to preclude the possibility of agitation by an air stream.

2 *Two-Phase Systems* (solid—liquid).

Type A—Viscous Materials: Colloidal mixtures such as wet clays, ramming mixes, various organic undehydrated fertilizers, and so forth.

Also, as a special case, granules in a viscous matrix material, such as damp deliquescent salts, core sands with resinous binders, flotation concentrates, and so forth.

Theory: These materials may exhibit Newtonian and non-Newtonian viscosity and plasticity, with the latter the most troublesome. Plastic flow requires a certain threshold force, below which flow will not take place, and resistance to viscous flow may *increase* with the *rate* of force application.

Conclusion: The slow, large-amplitude-displacement device, positively exceeding threshold resistances and supplying high, hydraulic "extrusive" forces at *low* rates of force application can be expected to be more effective than small-amplitude, high-frequency devices. Aeration would not be selected in this case.

Type B—Dilatant Materials: A liquid matrix (such as water) with small granules physically impervious to the liquid (such as sand). Examples are wet sand, wet fly ash, and so forth.

Theory: Vibration has a tendency to "pack" such material, causing settling of the solid phase by orienting the particles so as to produce minimum voids; any excess liquid becoming supernatent. Slowly applied, large displacement forces cause apparent "drying," by disorienting the particles, and creating total interstitial volumes in excess of the liquid volume.

Conclusion: Pure dilatancy would be difficult to handle by vibration as well as

[10] Gerotor May Corporation, Baltimore, Md.

[11] The Tainton Company, Baltimore, Md.

[12] "Storage and Handling of Pulverized Materials," by Francis Silver, MECHANICAL ENGINEERING, vol. 73, September, 1951, pp. 730–734.

[13] The Gerotor May "PneuBin."

by displacement devices, the surface tension of the film adhering to particle surfaces tending to make interparticle movement extremely difficult to initiate. However, either vibration or displacement would be expected to be superior to aeration.

Type C—Thixotropic Material: Very small particles with liquid in excess of that required to fill the voids such as very fine wet sands, drilling muds, and so forth.

Theory: Thixotropic materials become fluid when subjected to rapid agitation; but tend to segregate (freeze up) with gentle treatment.

Conclusion: The rapid, small-amplitude treatment provided by vibration would be expected to be most effective, and neither aeration nor the displacement devices would be chosen.

3 *Two-Phase Systems* (solid-gas). Very fine flocculent materials capable of being mixed with and retaining gas (air) as an envelope around the particles. Examples are flour, cement, dry fly ash, sulphur, talc, pigments, and so forth.

Theory: If the air phase can be maintained, these materials exhibit very fluid characteristics, being internally lubricated, so to speak, by an air envelope around every particle.

Conclusion: Mechanical vibration would have a tendency to cause segregation of the two phases, and packing or densification of the solids may result; as in the case of cement transported by hopper car. The loss of the air involved makes such materials more difficult to feed. However, if vibration is confined to discharge periods, it would be expected to be effective in maintaining flow in the column of material *directly over the discharge*, which is free to move and, therefore, is not deaerated by vibration. Aeration would be expected to be extremely effective, whereas the displacement type of device would have to be used with the panels in more horizontally disposed positions than usual in order to "fluff up" such materials instead of setting up internal air-expelling forces by squeezing.

4 The special case of materials tending to aggregate or "cake" on standing, due to interparticle crystallization, freezing, and the like.

Theory: Such materials either must be agitated during storage to prevent aggregation, or large forces must be applied to cause break-up before flow can be established. Examples of such materials are alkali nitrates, granulated sugar, many granular chemical salts containing water of crystallization, and wet granular materials stored at subfreezing temperatures.

Conclusion: The displacement type of device can be used to provide very low rates of agitation with large displacement forces to prevent such aggregation, or to provide the necessary large forces required to break up such aggregation after it has occurred, provided bin construction is sufficiently sturdy. A further complication often introduced by such material is that masses, too large to pass through the discharge, may remain unfractured and, in this instance, the displacement type of device appropriately situated will apply the forces necessary to fracture the mass immediately at the discharge.

After such material is recomminuted it may, of course, exhibit any one of a number of flow characteristics.

While the writers have attempted to reach their conclusions on theoretical grounds, in so far as was permitted by their knowledge of the subject, there is a close correspondence between the solutions suggested by theory, and those which experience with the three types of devices has shown to be effective.

AUTHOR'S CLOSURE

Mr. Davis and Mr. Pottberg have added substantially to the thinking along this line, both with the entirely new type of device they have developed, and with their particular classification of materials and methods for handling them. A few more contributions of this magnitude should provide us with a fairly adequate approach to the field of bulk material handling. As was suggested in the appendix to the original article, progress may be stepwise, by closer and closer approximations, rather than by the discovery of the ultimate equation. Persons with even small steps to add to the theory should come forward with the information as they will thereby stimulate the thinking of the rest of us, and hasten the day when the "by guess and by gosh" in material handling is replaced by adequate predictable methods.

A few other papers on the problems involved in handling specific materials such as cement or coal, and some papers illustrated with pictures of the flow lines formed in glass-sided model bins should get this problem "out on the table" ready for mathematical analysis. If these papers should require more space than our MECHANICAL ENGINEERING would feel justified in using for this one subject, we can call on some of the other journals. For instance, Mr. James Bright, editor of *Modern Materials Handling*, has expressed a willingness in helping to publish papers on this subject.

Ten per cent may be a conservative estimate of the loss in productive man-hours from irregular flow of materials, from "padding" plant labor forces with extra men to handle stoppages, and from diversion of attention of operators and supervisors from productive thought to wondering when the next interruption will occur. Whatever the figure may be, certainly it is substantial and worth saving.

FRANCIS SILVER.[14]

Indicating Gages

COMMENT BY J. H. FER[15]

A property of indicating gages frequently discussed is magnification. The following are the approximate magnifications realized with the three gaging methods employed on the machine described in the paper:[16]

	Magnification	Gaging tolerance
Air-electric combination	100:1[a]	±0.0004
Reed amplifying gage	25:1	±0.0075
Linkage to microswitch	1:1	Max only, or min only

[a] As to whether this arrangement is capable of higher magnifications in other applications, the writer is not in a position to state.

AUTHOR'S CLOSURE

The author believes, from the manufacturer, that very considerably higher magnifications are possible with the air-electric gage.

However, the possibilities will be largely dependent on the application, and anyone's contemplating the use of such gages would be well advised to consult the gage manufacturer and get his advice as to what magnification is practical for the specific requirement.

G. M. FOSTER.[17]

Correction

Frederick Oederlin, author of the paper "Engineering Achievements in Switzerland and Their Background," published in the November issue of MECHANICAL ENGINEERING, writes that on page 881 under "Internal-Combustion Engine—1937" the phrase "with supercharged twelve-cylinder two-stroke engines" should read "*four-stroke*."

[14] Chemical Engineer, Martinsburg, W. Va. Jun. ASME.

[15] Manufacturing Standards and Gage Design Engineer, Northern Electric Company, Limited, Montreal, Que., Can.

[16] "Design of a Semiautomatic Gaging-and-Sorting Machine," by G. M. Foster, MECHANICAL ENGINEERING, vol. 73, September, 1951, pp. 713–718.

[17] Assistant Superintendent, Manufacturing Engineering, Communications Equipment Division, Northern Electric Company, Montreal, Quebec, Canada. Mem. ASME.

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Josiah Willard Gibbs

JOSIAH WILLARD GIBBS: The history of a great mind. By Lynde Phelps Wheeler. Yale University Press, New Haven, Conn., 1951. Cloth, 6 × 9¼ in., illus., appendixes, index, xi and 264 pp., $4.

REVIEWED BY JESSE ORMONDROYD[1]

JOSIAH WILLARD GIBBS, professor of mathematical physics in Yale University from 1871 to 1903, was the greatest scientist produced to date in the western hemisphere. He was the last of that long line of classical physicists, starting from Aristotle and Archimedes, who attempted to describe the universe in mechanical terms. The work that makes him famous was in the fields of thermodynamics and statistical mechanics—those subjects which rounded out and finished the theory of pre-Einsteinian mechanics. Gibbs was a theoretical mathematical physicist, interested in the formal development of his subjects using the experimental results of others and never making experiments of his own. As a mathematician, Gibbs was the creator of the vector analysis which is taught in all the schools today. This creation—and it *was* something new—Gibbs considered only as an adaptation of the ideas in Grassmann's "Ausdehnungs lehre" and Hamilton's "Quaternions."

During his lifetime Gibbs was known only to other physicists, mainly to European physicists. His fame has grown as his work found ever-widening application, particularly in chemistry. He is now sufficiently well known to physicists, mathematicians, and engineers in this country to make a biography of understandable interest. Dr. Wheeler's biography is an "official" biography in the sense that it was created by the close co-operation of Gibb's surviving students, his surviving relatives, and Yale University. The flyleaf of the biography announces it as "a publication issued on the occasion of Yale's 250th anniversary." By its publication Yale honors both herself and her greatest "son" in the field of science. In a communication to the *American Scientist* of April, 1951, E. B. Wilson reviews the genesis and development of Wheeler's biography of Gibbs and makes bitter comments on the two unauthorized full-length biographies that have appeared in the past.

Gibbs is of particular interest to engineers because the inspiration for all his work was applied physics—in spite of the fact that his work is so theoretical and so logically compact that few engineers can read it either with pleasure or profit. Gibbs received the first doctor's degree in engineering ever given in the United States. His thesis was on the shape of gear teeth in spur gears. Early in his career he invented an inertia brake for railway cars, a sensitive and stable flyball governor, and a hydraulic turbine. Having paid his respects to contemporary problems in engineering, Gibbs spent the rest of his life creating the tools for future engineers—tools to be used for the most part after he was dead.

All of Gibbs's important papers are gathered together in a two-volume work entitled "The Collected Works of J. Willard Gibbs," issued originally by the Yale University Press in 1906 and later reprinted, somewhat enlarged, in 1948. The papers in these volumes are so abstract and difficult to understand that a two-volume "Commentary on the Scientific Writings of J. Willard Gibbs" was issued by the Yale University Press in 1936. These commentaries were written by former students and later disciples. These four volumes could be likened to Siamese quadruplets. Gibbs's original work is hard to understand without the commentary and the commentary is almost meaningless without the original papers being available for reference. In 1901, on the occasion of Yale's Bicentennial, E. B. Wilson published Gibbs's "Vector Analysis," enlarging on the 74 pages of vector analysis contained in the collected works. This volume was also issued by the Yale University Press. In 1947 the record of Gibbs's work was almost completed in a small volume entitled "Early Work of Willard Gibbs in Applied Mechanics." The book, assembled by Wheeler with the help of Professors Waters and Dudley, contains the thesis on gear teeth and a discussion of the railway-car brake and the governor invented by Gibbs. Finally, Gibbs's very first paper, on "The Proper Magnitude of the Units of Length and of Other Quantities Used in Mechanics," is to be found in appendix 2 of Wheeler's biography.

The growing recognition of Gibbs's work in thermodynamics and chemistry make Wheeler's biography of this great American scientist of timely interest to all engineers.

[1] Professor, Engineering Mechanics Department, University of Michigan, Ann Arbor, Mich. Mem. ASME.

Combustion, Flames, and Explosions of Gases

COMBUSTION, FLAMES, AND EXPLOSIONS OF GASES. By Bernard Lewis and Guenther von Elbe. Academic Press Inc., New York, N. Y., 1951. Cloth, 6 × 9 in., xix and 795 pp., 355 figs., tables, appendix, index, $13.50.

REVIEWED BY B. A. LANDRY[2]

THE title of this book is the same as that used for another book, by the same authors, published in 1938. However, the similarity between the two books practically ends there, so that this new work should not be construed as a "second edition."

Lewis and von Elbe are generally recognized as the deans of American research workers in their chosen field of fundamentals of gas combustion. In 1938 few Americans were engaged in similar work. Today, because of the advent of turbojet propulsion of aircraft and that of rocket missiles, the general field of high-intensity combustion is the subject of much activity. Hence this book will be well received by all those interested in fundamental combustion work not only because of the reputation of the authors, but also because of the great strides made toward the understanding of combustion phenomena to which no small part is due to the authors,

[2] Battelle Memorial Institute, Columbus, Ohio. Mem. ASME.

themselves, and their associates at the Bureau of Mines.

The book is divided into four parts. The first deals with the chemistry and kinetics of the reactions between fuel gases and oxygen. This is the physical-chemist's approach to combustion theory. Much excellent and difficult work has been done in this approach and many data have been obtained that explain quite well peculiarities of behavior of homogeneous and heterogeneous reactions. The reader is left with the impression, however, that much more remains to be done before a compact and effective theory can emerge.

The second part is devoted to flame propagation. This is the mechanistic approach which involves the aerodynamics of flames, particularly of the "combustion waves" associated with flames. The mathematical treatment of results of many clever experiments is often clear and convincing. Yet, a choice seems to remain between alternate or opposed viewpoints, particularly on the basic assumptions of the mechanisms proposed. The discussion on ignition removes much of the former confusion surrounding the subject.

The third part concerns the state of the burned gas. Thermodynamics and flame spectroscopy finally come into their own without raising questions.

The fourth part deals very briefly with some of the technical applications. Here the art is so far in advance of the science that precious few of the developments of the previous parts seem applicable. The authors must fall back on empirical observations, as everyone else.

This book will recommend itself primarily to the scientist and to those engaged in combustion research. To the busy mechanical engineer, facing immediate difficult technical problems in combustion, this work will not serve as a panacea, nor is it intended to be one; but it will be evidence that great effort is being applied to the fundamental understanding of combustion on which progress in the art must ultimately rest.

Books Received in Library

ASTM STANDARDS ON PETROLEUM PRODUCTS AND LUBRICANTS (with related information). Prepared by ASTM Committee D-2, published annually by the American Society for Testing Materials, Philadelphia, Pa., 1951. Paper, 6×9 in., 783 pp., charts, tables, diagrams, $5.75. The 129 standards published in this compilation include 116 test methods; 7 specifications; 1 classification; 3 lists of definitions relating to petroleum, specific gravity, and rheological properties of matter; and 2 tentative recommended practices. The standards are arranged in broadly classified groups, with an additional listing of the contents in numerical order of the standards designation.

ASTM STANDARDS ON TEXTILE MATERIALS (with related information). Prepared by Committee D-13 on Textile Materials, issued annually. American Society for Testing Materials, Philadelphia, Pa., 1951. Paper, 6×9 in., 595 pp., illus., tables, diagram, $3. The following wide range of topics is covered by the 88 specifications, test methods, and tolerances presented: asbestos, bast and leaf fibers, cotton, glass textiles, rayon and silk, wool, pile fabrics, and felt; general fibers, fabrics, yarns, threads, and cordage; identification, qualitative and quantitative analysis; resistance to insect pests and microorganisms; testing machines. There are tests on snag resistance and stretch of hosiery and other specialized items. A group of useful tables is appended and an extensive glossary of textile terms is given including photographic illustrations of fabric defects.

ACTES DU COLLOQUE INTERNATIONAL DE MÉCANIQUE, Poitiers, France, 1950, vol. 2: ÉTUDE SUR LA MÉCANIQUE DES FLUIDES. France, Ministère de l'Air, Publications Scientifiques et Techniques. No. 250, 1951. Paper, 7 × 10½ in., 294 pp., illus., charts, diagrams, 1800 fr. This second volume of a report on an international conference on mechanics contains seventeen papers on various subjects more or less connected with fluid mechanics: exterior ballistics; analysis of the movement of projectiles by ultra-rapid photography, etc.; and considerations of subsonic, transonic, and supersonic aerodynamics from various specialized aspects.

BERECHNUNG MECHANISCHER SCHWINGUNGEN. By Fritz Söchting. Springer-Verlag, Wien, Austria, 1951. Cloth, 6¼ × 9¼ in., 325 pp., charts, tables, diagrams, $9.80. A brief section on fundamentals introduces this analytical treatment of mechanical vibrations. The following two sections deal, respectively, with conventional representations of single-mass and multiple-mass systems. The vibration of elastic bodies is discussed at considerable length in section 4, and the final section is devoted to actual machine elements, instrument parts, and such physical objects as propellers, ships, and so on.

BUCKLING STRENGTH OF METAL STRUCTURES. (Engineering Societies Monographs.) By Friedrich Bleich. With the collaboration of Commander Lyle B. Ramsey, U.S.N. and edited by Hans H. Bleich. The McGraw-Hill Book Company, Inc., New York, N. Y., 1952. Cloth, 6 × 9½ in., 508 pp., charts, tables, diagrams, $10. This latest addition to the Engineering Societies Monographs list presents an extensive analysis of the behavior of fabricated-steel structures under compression loading especially applicable to structural and ship design. Covering a wide range of subjects from the buckling of columns to stability of web plates and special problems in the design of ship plating, the book presents practically applicable methods, formulas, tables, and graphs. The many footnotes and additional lists of references reflect the breadth of the literature surveyed in addition to the original work included.

FOUNDRY WORK. By Edwin W. Doe. Prepared in co-operation with The Textbook Committee of the Educational Division, American Foundrymen's Society. John Wiley and Sons, Inc., New York, N. Y., 1951. Cloth, 6 × 9¼ in., 109 pp., illus., diagrams, $1.76. This text is intended to teach the simple principles of foundry practice, first, by referring to the several phases of the industry in a general way, and secondly, by arranging a series of molding problems that will exemplify the application of this knowledge in a practical manner. A glossary and a list of foundry-job classifications are included.

PIPING STRESS CALCULATIONS SIMPLIFIED. Fourth printing. By S. W. Spielvogel, author and publisher, Lake Success, New York, N. Y., 1951. Fabrikoid, 9 × 11½ in., 114 pp., diagrams, charts, tables, $4.50. Exact solutions are provided for a large number of typical problems in the calculation of pipe stress under changing conditions of temperature. The solutions are presented in arithmetical form, and the mathematical theory involved is discussed. The book is intended to assist the designer of piping layouts. Some thirty extra pages of data tables have been added in the current edition.

PRINCIPLES OF MECHANISM. By F. Dyson. Fourth edition. Oxford University Press, London, England; New York, N. Y.; Toronto, Canada; 1951. Cloth, 5¾ × 8¾ in., 368 pp., diagrams, charts, tables, $3. This text aims to give a comprehensive presentation of the fundamental principles that apply to the moving parts of machines, adapted to the needs of students of engineering. Many worked-out examples of problems in velocity, acceleration, gearing, friction, belting, flywheels, governors, and balancing are given, together with a large number of problems for solution by the student.

PUNCHED CARDS, Their Applications to Science and Industry. Edited by R. S. Casey and J. W. Perry. Reinhold Publishing Corporation, New York, N. Y., 1951. Linen, 6¼ × 9¼ in., 506 pp., illus., diagrams, charts, tables, $10. The primary purpose of this book is to furnish sufficient information to the individual engineer, scientist, or technologist so that he may apply punched-card techniques to individual problems. The five parts of the book are: punched-card fundamentals; case histories of punched-card applications; general and fundamental considerations; future possibilities of applying mechanized methods to scientific and technical literature; and a bibliography on uses of punched cards.

SEAMLESS STORY. By J. P. Boore. Commonwealth Press, Los Angeles, Calif., 1951. Fabrikoid, 6 × 9¼ in., 285 pp., illus., tables, $5.75. A nontechnical history of seamless tubing, this book traces the evolution of tubing without seams or welds from its invention to contemporary mills. Biographies of inventors and important persons in the industry and information about companies are given. Included is an extensive bibliography listing patents, technical articles, and books.

THEORY OF PERFECTLY PLASTIC SOLIDS. By W. Prager and P. G. Hodge, Jr. John Wiley & Sons, Inc., New York, N. Y.; Chapman & Hall, Ltd., London, England, 1951. Paper, 6 × 9¼ in., 264 pp., diagrams, charts, $5.50. An introduction—on the intermediate level—to a particular branch of the general theory of plasticity. Although treating "mathemati-

cal" theory, the material has been chosen for its usefulness to the research engineer and the student of engineering. For example, the behavior of trusses, beams, slabs, etc., under various forces is considered as well as certain processes such as metal punching and extrusion.

TIMESTUDY FUNDAMENTALS FOR FOREMEN. By P. Carroll. Second edition McGraw-Hill Book Co., Inc., New York, N. Y.; Toronto, Canada; London, England, 1951. Cloth, 5 × 7½ in., 209 pp., illus., diagrams, charts, tables, $3. Step-by-step procedures are given from the beginning of a time study to the setting of standards from time-study data. Emphasis is placed on the actual value to be gained from time-study determinations and the reasons for each element in the procedure.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting December 14, 1951, and approved by the Board, February 14, 1952.)

CASE NO. 1106-1 (REOPENED)

(Interpretation of Pars. U-68, U-69 and U-70)

Inquiry: Will unfired pressure vessels fabricated by fusion welding under the requirements of Pars. U-68, U-69 and U-70 meet the intent of the Code if the base metal is copper-nickel alloy conforming to Specification SB-111 or SB-171?

Reply: It is the opinion of the Committee that copper-nickel alloy conforming to Specification SB-111 or SB-171 may be used for the construction of unfired pressure vessels by fusion welding under the general requirements of Pars. U-68, U-69 and U-70 provided:

(1) The welding requirements of these paragraphs and Section IX of the Code shall apply with the following limitations:

(a) Qualification tests made on a given thickness of material shall apply to thicknesses varying as much as ±50 per cent from that thickness. Not more than two thicknesses need be qualified, but they shall cover the minimum and the maximum thicknesses under consideration.

(b) The elongation as determined by the free bend test shall be not less than 30 per cent.

(2) Stress relieving is not required.

(3) The hydrostatic test described in Par. U-77 shall be conducted at a pressure equal to 1½ times the working pressure. In case the vessel is to be operated at temperatures exceeding 150 F, the hydrostatic test pressure shall be based on the maximum allowable pressure to be stamped on the vessel, increased by the ratio of the allowable stress at 150 F, and the corresponding allowable stress as given in Table 1 of this Case, interpolated if necessary, for the maximum working temperatures to be stamped on the vessel.

(4) The design rules of the Code shall be applied using the allowable working stresses contained in Table 1 of this Case multiplied by:

(a) For Par. U-68 construction 90 per cent joint efficiency.

(b) For Par. U-69 construction 80% joint efficiency.

(c) For Par. U-70 construction the joint efficiency shall be computed by dividing the SE values given in Pars. U-70(a) and U-70 (b) by 11,000.

(5) In view of the fact that this material is not one of those which suffer loss of impact resistance at low temperatures, the requirements of Pars. U-140, U-141 and U-142 shall not apply.

TABLE 1 MAXIMUM ALLOWABLE DESIGN STRESSES FOR COPPER-NICKEL ALLOYS, IN POUNDS PER SQUARE INCH

Material	Specification	For metal temperatures not exceeding degrees F										
		Sub Zero to 150	250	300	350	400	450	500	550	600	650	700
Copper Nickel 70-30	SB-111 Seamless Condenser Tubes Annealed	13,300	12,700	12,300	12,000	11,700	11,300	11,000	10,500	10,000	9,500	9,000
	SB-171 Tube Plates Annealed	12,500	12,500	12,200	12,000	11,700	11,300	11,000	10,500	10,000	9,500	9,000
Copper Nickel 80-20	SB-111 Seamless Condenser Tubes Annealed	12,000	11,300	11,000	10,700	10,300	10,000	9,500	9,000	8,500	8,000	7,500
Copper Nickel 90-10	SB-111 Seamless Condenser Tubes	10,000	9,500	9,300	9,000	8,700	8,300	7,500	6,700	6,000		

CASE NO. 1146-1 (REOPENED)

Inquiry: Pending issuance of emergency alternate specifications by ASTM to reflect the conservation of critical alloying material, may the molybdenum content of Code specifications of material containing 0.45 to 0.65 per cent molybdenum be reduced by 0.05 per cent, and specifications containing 0.90 to 1.10 per cent molybdenum be reduced by 0.10 per cent?

Reply: It is the opinion of the Committee that the intent of the Code will be met if specifications with a molybdenum range of 0.45 to 0.65 per cent are reduced to 0.40 to 0.60 per cent, and specifications with a molybdenum range of 0.90 to 1.10 per cent are reduced to 0.80 to 1.00 per cent. The allowable stresses assigned to these grades need not be reduced.

CASE NO. 1148

(Interpretation of Par. H-12 and Table H-1)

Inquiry: May steel boiler heads with welded instead of rolled tubes be considered to meet the requirements of Table H-1 if the heads are not thinner than the specified minimum shell plate thickness?

Reply: It is the opinion of the Committee that steel boiler heads which are fully supported by stays, braces, and/or welded-in tubes may be considered to meet the requirements of Table H-1 if the heads are not thinner than the specified minimum shell plate thickness.

Case Annulled

Case No. 1142 (Special Ruling) can now be annulled as the essence of this case has been incorporated in Case No. 1106-1 (Reopened).

Proposed Revisions and Addenda to Boiler Construction Code

AS need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code. Simple changes are indicated directly. In the more involved revisions added words are printed in SMALL CAPITALS; deleted words are enclosed in brackets [].

Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Material Specifications 1949

Editorial Note

The Boiler Code Committee has approved the addition to Section II of the following new specifications:

SA-312-51T, Specification for Seamless and Welded Austenitic Stainless Steel Pipe.

SA-325-49T, Specification for Quenched and Tempered Steel Bolts and Studs with Suitable Nuts and Plain Washers.

Unfired Pressure Vessels, 1950

PAR. UW-52 Revise to read:

UW-52 *Spot-Examination of Welded Joints* (a) Vessels and parts of vessels that have longitudinal and circumferential welded joints that are not radiographed for their full length shall be examined locally by spot-radiographing, or by sectioning, or by a combination of spot-radiographing and sectioning as provided herein, with the following exception:

(b) The mandatory spot-examination requirements in (a) may be waived for vessels and parts of vessels that are designed on the basis of a reduced stress value equal to 80 per cent of the allowable stress value prescribed for the material in Subsection (c)* and on the joint-efficiency factors prescribed in Par. UW-12.

(c) *Number of Examinations* Spots shall be examined at points designated by the inspector in accordance with the following schedule:

(1) One spot-examination shall be made in vessels having 50 feet or less of longitudinal and circumferential main seam welds that are not fully radiographed. Two spot-examinations shall be made in vessels having more than 50 feet of such welds. One spot-examination only need be made for each 50 feet of the total length of longitudinal and circumferential main seam welds that are not fully radiographed in a number of similar vessels built at the same time and under the same specifications, provided that the length of such welds in each vessel is less than 50 feet.

(2) One spot-examination shall be made for each welding procedure and for each welder or welding operator qualified under Section IX that is used on a vessel or group of vessels as defined in (1).

(3) Any spot examined may coincidentally represent one specified footage of weld, one welding procedure, and one welder or welding operator.

(d) *Standards for Spot-Radiography* Spot-examination by radiography shall be made in accordance with the technique prescribed in Par. UW-51. The required length of spot radiographs is 6 in. Spot radiographs may be retained by the fabricator or be discarded after acceptance of the vessel by the inspector. The acceptability of welds examined by spot-radiography shall be judged by the following standards:

(1) Welds in which the radiographs show any type of crack or zones of incomplete penetration shall be unacceptable.

(2) Welds in which the radiographs show slag inclusions or cavities shall be unacceptable if the length of any such imperfection is greater than $^{2}/_{3}$T where T is the thickness of the thinner plate welded. If several imperfections within the above limitations exist in line, the welds shall be judged acceptable if the sum of the longest dimensions of all such imperfections is not more than T in a length of 6T (or proportionately for radiographs shorter than 6T) and if the imperfections are separated by at least 3L of acceptable weld metal, where L is the length of the longest imperfection. The maximum length of acceptable defect shall be $^{3}/_{4}$ in. Any defect shorter than $^{1}/_{4}$ in. shall be acceptable for any plate thickness.

(3) Porosity is not a factor in the acceptability of welds.

(e) *Sectioning* (1) When the welded joint is to be examined by sectioning, the specimens removed shall be such as to provide a full cross section of the welded joint and may be removed by trepanning a round hole or by any equivalent method.

(2) The specimens shall be ground or otherwise smoothed and then etched by any method or solution which will reveal the defects without unduly exaggerating or enlarging them (See Appendix K).

(3) If sections are oxygen-cut from the vessel wall, the opening in the vessel wall shall not exceed $1^{1}/_{2}$ in. on any diameter, or the width of the weld, whichever is greater, as measured after removal of all loose scale and slag accumulation. Oxygen-cut specimens shall be sawed across the weld to obtain a plane surface which will expose the full width of the weld on the cut surface.

(4) Sections removed from the welded joint shall not show any types of cracks or zones of incomplete fusion or inadequate joint penetration. Gas pockets and slag inclusions shall be permissible only:

(a) When the width of any single slag inclusion between layers of weld metal substantially parallel to the plate surface is not greater than one-half the width of the sound weld metal where the slag inclusion is located;

(b) When the total thickness of all of the slag inclusions in any plane at approximately right angles to the plate surface is not greater than 10 per cent of the thickness of the thinner plate;

(c) When there are gas pockets that do not exceed $^{1}/_{10}$ in. in greatest dimension and when there are no more than six gas pockets of this maximum size per square inch of the weld metal or where the combined areas of a greater number of pockets do not exceed 0.02 sq in. per square inch of weld metal.

(5) The segments or plugs after removal shall be properly stamped or tagged for identification and, after etching, kept in proper containers, with a record of their place of removal as well as of the welder or welding operator who performed the welding. A record shall be made by the inspector of all specimens with their identification marks on a developed shell plate diagram. After the acceptance of the vessel, the specimens may be retained by the purchaser if he so desires. Otherwise they may be discarded.

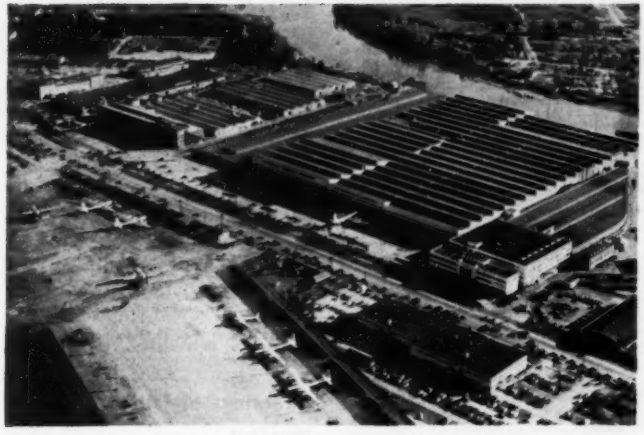
(f) Openings resulting from the removal of specimens may be closed by any welding method approved by the inspector. Some acceptable procedures for closing openings resulting from sectioning are given in Appendix K.

(g) *Procedure for Spot-Re-examination* When a spot has been examined and the welding does not comply with the minimum quality requirements referred to in (d) for radiographing or in (e) for sectioning, two additional spots shall be examined by either method in the same seam at locations to be selected by the inspector, one on each side of, and not far from the original spot in order to determine the limits of the deficient welding, and if the welding at either of these spots fails to comply with the requirements in (d) for radiographing or in (e) for sectioning, additional nearby spots shall be examined until the limits of unacceptable welding are determined. In addition, the inspector shall require that an additional spot be examined by either procedure to one location selected by him in each seam not previously examined on which the same operator has welded and that, in case any additional spot fails to comply with the requirements in (d) or (e), the limits of unacceptable welding shall be determined as above described. All rewelded areas shall be re-examined as required by the inspector and shall comply with the requirements in (d) or (e).

* This refers to the forthcoming 1952 Edition of Pressure Vessels.

ASME NEWS

With Notes on the Engineering Profession



BOEING AIRPLANE COMPANY PLANT 2, IN SEATTLE, WASH.

(Seattle is the headquarters and home office of Boeing Airplane Company. Plant 2, which includes many of the company's research facilities, was the home of World War II B-17's and later supplied major assemblies of the production of B-29's delivered from the nearby Renton plant. This is just one of the many places to visit while attending the 1952 ASME Spring Meeting to be held at the University of Washington, Seattle, Wash., March 24-26, 1952.)

Varied Technical Program Arranged for 1952 ASME Spring Meeting

University of Washington, Seattle, March 24-26

LIVING as we are in an atomic age, it is appropriate that one of the technical sessions scheduled for the Spring Meeting of The American Society of Mechanical Engineers should be devoted to nuclear energy. The Spring Meeting is to be held at the University of Washington in Seattle, Wash., from March 24 to 26, 1952.

Arrangements have been made by Region VII to hold its 1952 Regional Administrative Committee Meeting at the University of Washington on Sunday, March 23, taking advantage of the fact that by that day many of the members of ASME will have forgathered to attend the sessions of the Spring Meeting.

Technical Program

The technical program, highlighted by the session on nuclear energy, also includes important sessions on aviation, steam-power generation, materials handling, wood industries, fuels, machine design, metals engineering, gas-turbine power, management, applied mechanics, and hydraulics. In all there will be 17 technical sessions at which 44 papers will be presented.

Governor to Address Luncheon

The Hon. A. B. Langlie, Governor of the State of Washington, will give the address of welcome at the President's Luncheon, on March 24, at 12:15 p.m. R. J. S. Pigott, president, ASME, will speak on the subject, "Are We Self-Supporting in Energy Supply?" Conant Dodge, chairman of the Western Washington Section, ASME, will preside.

Roy V. Wright Lecture

Prof. B. M. Woods, professor of mechanical engineering, has been chosen to deliver the Roy V. Wright Lecture at the luncheon on Tuesday, March 25, at 12:15 p.m. Mr. Pigott will preside at the Wright Luncheon. Professor Woods will speak on "Engineers' Civic Responsibility—An Action Program."

This lecture was established in 1949 to honor Roy V. Wright, President of the Society in 1931, as a tribute to his contributions as a citizen to the nation and his community. The purpose of the lecture is to impress on engineers the duties and privileges of citizenship in a democracy.

Banquet

E. O. Eastwood, Fellow ASME, will serve as toastmaster at the banquet planned for Tuesday evening, March 25. The speaker of the evening will be Roderic Olzendam, director of Social Security for the State of Washington. He will give a talk on human engineering.

Women's Program

The women's program lists such social events as the Coffee Hour, invitations to attend the various luncheons and the banquet, sight-seeing trips through scenic Seattle and the surrounding suburbs, the campus of the University of Washington, the field trips to the U. S. Plywood Corporation or the Pacific Car and Foundry, and a luncheon and style show at Frederick and Nelson's Dining Room.

MONDAY, MARCH 24

8:00 a.m.

Registration

9:30 a.m.

Aviation (I)—Heat Transfer

A New Method of Performance Analysis on Air Cycle Cooling of a High-Speed Airplane, by *D. E. Brimley*, Douglas Aircraft Company, Inc., Santa Monica, Calif. (52—S-5)

University of California's New Aeronautics Facilities, by *Earl Janssen*, department of engineering, University of California, Los Angeles, Calif. (52—A-6)

Dynamic Buckling of Thin Elastic Plates, by *George Ziscas*, University of California, Los Angeles, Calif. (52—S-3)

9:30 a.m.

Power (I)

Broom Closets or the Effect of Maintenance Upon Design of Steam-Power Plants, by *B. C. Mallory*, chief mechanical engineer, and *F. W. Argue*, assistant chief, power engineering, Stone and Webster Engineering Corporation, Boston, Mass.

Etiwanda—A Study in Over-All Steam-Station Economy, by *W. L. Chadwick*, vice-president in charge of engineering and construction, Southern California Edison Company, Los Angeles, Calif., and *E. H. Krieg*, consulting engineer, Stone and Webster Engineering Corporation, Boston, Mass. (52—S-10)

9:30 a.m.

Materials Handling (I)

Planning an Efficient Motor Truck-Dock, by *Neil Drake*, Drake, Startzman, Sheahan and Barclay, New York, N. Y.

Selecting and Training Fork-Truck Operators, by *Donald Holm*, Hyster Company, Portland, Ore.

12:15 p.m.

President's Luncheon

Presiding: Conant Dodge, chairman, Western Washington Section ASME

Address of Welcome: The Honorable Arthur B. Langlie, Governor of the State of Washington

Speaker: R. J. S. Pigott, President and Fellow ASME
Subject: Are We Self-Supporting in Energy Supply?

2:30 p.m.

Aviation (II)

Pressures Required for Thin Press Forgings, by *William Schroeder*, Lockheed Aircraft Corporation, Burbank, Calif. (52—S-4)

Use of Honeycomb-Panel Construction in Military Lightweight Trailers, by *B. E. Del Mar*, Douglas Aircraft Company, Santa Monica, Calif., and *Herman Stumph*, Del Mar Engineering Laboratory, Los Angeles, Calif. (52—S-7)

Friction Surfaces for Spin-Up Simulation in Landing-Gear Drop Tests, by *Dan Drake*, research engineer, Lockheed Aircraft Corporation, Burbank, Calif. (52—S-1)

A Ramjet Development for the U.S.A.F., by *W. F. Hiltner*, Boeing Airplane Company, Seattle, Wash.

2:30 p.m.

Wood Industries

Some Technical Aspects of Trimming Lumber in the Planing Mill, by *Peter Koch*, assistant to the president, Stetson-Ross Machine Company, Seattle, Wash.

Problems in the Conversion of Residual Wood to Hardboard, by *G. G. Marra*, head, Wood Technology section, Washington State College, Institute of Technology, division of Industrial research, Pullman, Wash.

Hardboard-Faced Fir Plywood—Production and Specification, by *John Ritchie*, head, allied products department, Douglas Fir Plywood Association, Tacoma, Wash. (52—S-11)

Hydraulic Barking, by *L. E. Hill, Jr.*, Weyerhaeuser Timber Company, Everett, Wash.

2:30 p.m.

Power (II)—Fuels (I)

Technical and Commercial Factors Relating to Trans Mountain Oil Pipe Line, by *D. I. Roberts*, vice-president, Canadian Bechtel Limited, Vancouver, B. C., Can.

Design and Construction of Pacific Gas and Electric Company's 34-Inch Gas Line, by *J. J. Pugh*, Pacific Gas and Electric Company, San Francisco, Calif., and *Ray Hamilton*, Bechtel Corporation, San Francisco, Calif.

2:30 p.m.

Materials Handling (II)

The Key to Better Inter-Building Handling, by *T. S. Wilmeth*, assistant production-control manager, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Analysis Material Movement With Travel Charts, by *D. G. Cameron*, manager, manufacturing control department, General Electric Company, Schenectady, N. Y.

8:00 p.m.

Nuclear Energy

Ventilation Problems in Safe Handling of Radioactive Materials, by *W. W. McIndoe*, staff engineer, General Electric Company, Richland, Wash.

The Handling of Radioactive Materials, by *E. Hollister*, engineering department nucleonics division, General Electric Company, Hanford Works, Richland, Wash.

Problems of Technical Training for Nuclear Energy, by *B. T. McMinn*, professor and executive officer, mechanical-engineering department, University of Washington, Seattle, Wash.

What Do We Mean by Nuclear Engineering? by *D. W. McLenegan*, personnel officer, General Electric Company, Richland, Wash.

TUESDAY, MARCH 25

8:30 a.m.

Registration

9:30 a.m.

Fuels (II)—Power (III)

Burning Sulphite Waste Liquor, by *H. A. Sorensen*, professor, mechanical engineering, The State College of Washington, Pullman, Wash.

Turbulent Suspension Burning of Wet Wood, Bark, and Other Fuels, by *Otto de Lorenzi*, director of education and fuels consultant, Combustion Engineering - Superheater Inc., New York, N. Y.

9:30 a.m.

Machine Design

The Slow-Mo-Shun Gear and the Influence of Modern Gear Technology on Its Performance Characteristics, by *P. E. Forsythe*, area manager of engineering and commercial activities, and *M. L. Headman*, design engineer, Western Gear Works, Seattle plant, Seattle, Wash.

Latest Developments in the Application of Industrial Gearing, by *C. B. Connell*, section engineer, Gearing Division, Westinghouse Electric Corporation, Pittsburgh, Pa.

9:30 a.m.

Metals Engineering

The Importance of Carbon in Ferrous Metals to Engineers, by *H. K. Ihrig*, vice-president in charge of research, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Improvements in the Field Distillation of Peppermint Oil, by *A. D. Hughes*, professor, mechanical engineering, Oregon State College, Corvallis, Ore.

Steam-Turbine Generators for Industrial Plants—Their Design, Application, and Controls, by *S. D. Fulton*, general engineer, Steam Division, Westinghouse Electric Company, South Philadelphia, Pa.

12:15 p.m.

Roy V. Wright Luncheon

Presiding: R. J. S. Pigott, president and Fellow ASME
Speaker: B. M. Woods, professor, mechanical engineering, and director of university extension, University of California, Los Angeles, Calif.
Subject: Engineers' Civic Responsibility—An Action Program

2:15 p.m.

Plant Trips

U.S. Plywood or Pacific Car and Foundry

6:30 p.m.

Banquet

Toastmaster: E. O. Eastwood, professor emeritus, mechanical engineering, University of Washington, Seattle, Wash.
Speaker: Roderic Olsendam, director of social security for the State of Washington.
Address: Human Engineering

WEDNESDAY, MARCH 26

8:30 a.m.

Registration

9:30 a.m.

Gas Turbine Power (I)

The Free-Piston-Engine Development—Present Status and Design Aspects, by *A. L. London*, professor, mechanical engineering, Stanford University, Stanford, Calif., and *A. K. Oppenheim*, assistant professor, University of California, Berkeley, Calif.

The Pattern of Gas-Turbine Development in Europe and the U. S., by *F. T. Hague*, consulting engineer, Westinghouse Electric Corporation, Philadelphia, Pa.

9:30 a.m.

Management (I)

Is Western Management Up to Par? by *A. C. Prendergast*, editor, *Western Industry Magazine*, San Francisco, Calif.

The Role of the Estimator in Industry, by *W. A. Nordhoff*, chief machine-shop estimator, Douglas Aircraft Company, Los Angeles, Calif.

9:30 a.m.

Western Washington Section—Applied Mechanics

Torsion of a Circular Shaft With Diametrically Opposite Flat Sides, by *W. J. Carter* and *J. B. Oliphint, Jr.*, research engineer, Military Physics Research Laboratory, University of Texas, Austin, Texas

Effects of Vibration on the Design of Suspensions for Overhead Transmission Lines, by *R. F. Steidel, Jr.*, professor, mechanical engineering, Oregon State College, Corvallis, Ore.

2:30 p.m.

Gas Turbine Power (II)

Radial-Flow Compressors and Turbines for the Simple Small Gas Turbines, by *L. R. Weiske*, senior aerodynamicist, Solar Aircraft, San Diego, Calif.

Waste-Wood-Fired Gas-Turbine Power Package, by *G. H. Atherton*, mechanical engineer, Oregon Forest Products Laboratory, Corvallis, Ore.

The Function of a Boot-Strap Gas-Turbine Unit in University Work, by *M. Guiden*, mechanical engineering instructor, University of Washington, Seattle, Wash., and *Oliver Foss*, test engineer, North American Aviation, Inc., Los Angeles International Airport, Los Angeles, Calif. (52—S-8)

2:30 p.m.

Management (II)

Incentives With Predetermined Time Standards, by *A. J. Stuart*, industrial consultant, Alfred I. Stuart & Associates, Portland, Ore.

Scheduling Techniques for a Multiple Shipbuilding Program, by *A. N. Schrieber*, associate professor of management, College of Business Administration, University of Washington, Seattle, Wash.

2:30 p.m.

Western Washington Section—Hydraulics

Engineering Uses of Analog Computing Machines, by *C. B. Crumb, Jr.*, research engineer, physical research unit, Boeing Airplane Company, Seattle, Wash.

The New Rate Automatic-Pilot, by *C. R. Hanna, K. A. Oplinger*, and *G. R. Douglas*, research laboratory, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Improvement of Well Yield by Use of Vibratory Explosives, by *H. A. Mylander*, district engineer, Water Supply Analysts, South Pasadena, Calif.

Meetings of Other Societies

March 10–14
National Association of Corrosion Engineers, annual conference and exhibition, Galvez Hotel, Galveston, Texas

March 11–14
The Society of Plastic Industry, 5th national plastics exposition, Convention Hall, Philadelphia, Pa.

March 12
American Society for Testing Materials, joint meeting with Milwaukee Section, ASME, "Solving Problems in Materials," Engineers' Society of Milwaukee, Milwaukee, Wis.

March 17–21
American Society of Tool Engineers, industrial exposition, International Amphitheatre, Chicago, Ill.

March 20–22
Electrical Maintenance Engineers Association of Southern California, industrial show and technical conference, Veterans' Memorial Building, Culver City, Calif.

March 23
National Association of Power Engineers, national meeting, Hotel Sherman, Chicago, Ill.

March 25–28
National Power Show, Hotel Sherman, Chicago, Ill.

April 1–4
Greater New York Safety Council, 22nd annual safety convention, Hotel Statler, New York, N. Y.

April 7–8
American Management Association, production conference, Hotel Statler, New York, N. Y.

April 7–9
American Society of Lubrication Engineers, annual meeting and lubrication show, Hotel Statler, Cleveland, Ohio.

April 16–18
American Institute of Electrical Engineers, Detroit section, American Welding Society; and Industrial Electrical Engineers Society of Detroit, third annual welding conference, Rackham Memorial Building, Detroit, Mich.

(For ASME Calendar of Coming Events see page 262)

Centennial of Engineering

Officers Elected

IMPETUS has been given to the rounding-out of the great convocation of 51 national and international engineering societies, including The American Society of Mechanical Engineers, to be held in Chicago, Ill., Sept. 3 to Sept. 13, 1952, as part of the celebration of the Centennial of Engineering, with the election of Chancellor H. T. Heald of New York University, Mem. ASME, to the chairmanship of the convocation committee.

Other members of the committee are E. R. Weidlein, president of the Mellon Institute of Industrial Research, Pittsburgh; Frederick V. Geier, Assoc. ASME, president, Cincinnati Milling Machine Company, Cincinnati, Ohio; A. P. Greensfelder, chairman, Fruin Colnon Contracting Company, St. Louis, Mo.; and E. G. Bailey, past-president and Hon. Mem. ASME, vice-president, The Babcock & Wilcox Company, New York, N. Y.

The immensity of the Centennial program is reflected in the fact that practically all the major meeting rooms of six of Chicago's largest downtown hotels have been reserved for the sessions which will cover a 10-day period. This is in addition to a large number of meetings scheduled at the Museum of Science and Industry. The 1952 ASME Fall Meeting will also be held in Chicago at this time, from Sept. 8–11, inclusive, with headquarters at the Hotel Sheraton. ASME members are urged to make their reservations immediately to avoid inconvenience or disappointment.

Board of Directors

The vacancies on the Centennial's board were filled with acceptances of their election by David Sarnoff, chairman, Radio Corporation of America; J. M. Todd, past-president and Fellow ASME, James M. Todd Associates, New Orleans, La.; and Gano Dunn, Hon. Mem. ASME, and president of the J. G. White Engineering Corporation, New York, N. Y.

Other prominent members of the board include Herbert Hoover, Hon. Mem. ASME, only living former President of the United States; C. F. Kettering, Fellow ASME, General Motors research consultant; B. F. Fairless, president, U. S. Steel Corporation; and R. E. Wilson, chairman, Standard Oil Company of Indiana.

Officers of the Centennial in addition to Lenox R. Lohr, its president, are C. S. Proctor, president of the American Society of Civil Engineers, vice-president; T. G. LeClair, Commonwealth Edison Company, Chicago, and past-president of the American Institute of Electrical Engineers, treasurer; and C. F. Kettering, chairman of the executive committee.

Frank W. Edwards, Mem. ASME, on loan from Illinois Institute of Technology where he heads the department of civil engineering, is general manager of the Centennial; while E. L. Chandler, ASCE staff executive, is secretary of the convocation committee.

Centennial Slogan

In a move to awaken the public to the prominent part the engineering profession has played in bringing America to its present high economic and social levels, the Centennial of Engineering will build all of its activities around the slogan, "Human Well-Being Through Engineered Progress."

Women's Engineering Group Joins Convocation

It was also announced that for the first time in the history of the engineering profession, women will participate as a separate body in a national meeting of their career group. The recently organized Women's Society of Engineers will join with the other engineering groups of the country in celebrating the Centennial of Engineering.

The new women's engineer group was formed late this year and already includes more than 200 members from all sections of the country, and represents various branches of the engineering profession. It is headed by Beatrice Hicks, an executive of the Newark Control Company, Bloomington, N. J.

Important Notice to ASME Members

IF YOU are planning to attend the Centennial of Engineering to be held in Chicago, Ill., Sept. 3–13, 1952, during which time the ASME Fall Meeting will be held, Sept. 8–11, make your hotel reservations *without delay*. The Hotel Sheraton will be ASME headquarters.

MSA Advisory Group on European Productivity Named

Look to Increase Industrial Output

EIGHTEEN of America's leaders, 17 men and one woman, engaged in the fields of management engineering, labor, industrial relations, and economics, have been named to advise the Mutual Security Agency, successor to the Economic Cooperation Administration, on its European production assistance drive. Under the chairmanship of J. W. Nickerson, Mem. ASME, private consultant on management engineering, West Hartford, Conn., the new Advisory Group on European Productivity met for the first time on Jan. 3, 1952.

This drive to increase industry's output per man-hour, with lower costs and higher wages, is regarded as MSA's number one specific job in Europe at this time in the general program of building and supporting the free-world's defense potential, economic strength, and the will to resist communism.

Members of the group, which will meet several times a year in Washington, will provide their advice for the European productivity program through MSA's Productivity and Technical Assistance Division, which is headed by Everett H. Bellows. They may also be called upon to work on special problems and some may be asked to undertake special productivity missions to Europe.

Productivity Program

The productivity program of the Mutual Security Agency, like that of its predecessor, the ECA, is channeling American industrial methods and ideas to the free nations through study trips of European management, labor, and technical specialists to the United States, through the sending of American experts to work with governments, industries, and individual firms in other free nations, and by such other means as technical films, literature, and question-and-answer services.

Mr. Nickerson, chairman of the Advisory Group, who was appointed consultant on the productivity program November 1, 1951, under ECA, has been a private consultant on management engineering since 1949. He is a former director of the Management Consultant Division, War Production Board, and a graduate of the Massachusetts Institute of Technology. He held executive positions with Cheney Brothers, textile manufacturers, Manchester, Conn., for 27 years.

Other ASME Members

Phil Carroll, Fellow ASME, professional industrial engineer and a consulting engineer for 30 years in 160 plants, of 6 Crestwood Drive, Maplewood, N. J.; winner of the Gilbreth Medal in 1950.

William Gomberg, Mem. ASME, director of management engineering, International Ladies Garment Workers Union (AFL), consultant to the United Automobile Workers (CIO), United Automobile Workers (AFL), and United Textile Workers (AFL).

Harold B. Maynard, Mem. ASME, president of the Methods Engineering Council, of 718 Wallace Avenue, Pittsburgh; former president of the National Management Council for two years and deputy president of the International Committee on Scientific Management (CIOS); winner of the Gilbreth Medal in 1946.

David B. Porter, Mem. ASME, industrial engineering professor, New York University; winner of the Gilbreth Medal; received his basic training in scientific management from Henry Laurence Gantt.

Robert B. Wolf, vice-president 1920–1922, and Fellow ASME, consulting engineer, 84 Weed Street, New Canaan, Conn.; one of the chief proponents of the value of nonfinancial incentives; former manager of the Pulp Division of the Weyerhaeuser Timber Company, Longview, Wash.

EJC Discusses Unity Report

A MEETING of the Engineers Joint Council was held in the Engineering Societies Building, New York, N. Y., Jan. 25, 1952. T. G. LeClair, president EJC, presided.

Unity

A detailed report was received from the Exploratory Group to Consider Increased Unity of the Engineering Profession.

After a discussion of what immediate action should be taken on the report, it was voted "to receive the report of the Exploratory Group and refer it simultaneously to the Executive Committee and to the constituent societies of EJC for study and report back to EJC as soon as practicable."

It was also voted after further discussion "to transmit the report to the organizations represented on the Exploratory Group not constituent in EJC for a statement of probable action of each society if the recommended action is taken and an invitation extended to join a unity organization."

A letter from Everett S. Lee, Fellow ASME, was read which expressed a hope that action on a unity organization could be completed so that the announcement could be made at or before the Centennial of Engineering.

(For complete report, see page 255.)

Engineering Manpower Commission

T. A. Marshall, Jr., executive secretary, Engineering Manpower Commission, read excerpts from a statement prepared for submission to the Committee on Armed Services of the House of Representatives. He reported that the Engineering Manpower Commission had requested an opportunity and been invited to testify in connection with the hearings on Universal Military Training. EMC will be represented by Carey H. Brown, chairman, and Messrs. Shepard, Dargusch, Curtis, Trytten, Boring, and Marshall.

Mr. Marshall also reported that contributions from industry for the operations of EMC now totaled $46,325 and that the Commission was operating within contributions received. All monies advanced by EJC constituent bodies in 1951 for the Commission's work had been returned, he said.

International Relations

Activities in connection with the UPADI meeting in New Orleans, Aug. 26–30, 1952, were reported in detail by J. M. Todd, Fellow ASME, and 1951 president EJC. To establish a local U. S. group to complete and execute details of UPADI plans for the meeting, it was voted to appoint a UPADI Special Committee, to be headed by Mr. Todd.

Completion of a draft of a UPADI Constitution, now being further edited before transmittal to the UPADI Secretariat, was reported by S. L. Tyler.

EJC EXHIBIT AT THIRD NATIONAL CONFERENCE OF THE U. S. NATIONAL COMMISSION FOR UNESCO, HUNTER COLLEGE, NEW YORK, N. Y., JAN. 27–31, 1952.

(*Left*, I. I. Rabi, Nobel Prize winner, of the department of physics, Columbia University, and R. L. Goetzenberger, Fellow ASME, of Washington, D. C., view a segment of the Engineers Joint Council exhibition, showing the "Faith of the Engineer," at the Third National Conference. Mr. Goetzenberger represents the Council on the U. S. National Commission for UNESCO. Dr. Rabi is the representative of the American Institute of Physics on the Commission. Approximately 80 exhibits were arranged in the five exhibition halls of Hunter College.)

Centennial of Engineering

Plans for the Centennial and the Convocation were reported by E. L. Chandler. The Convocation, he said, will include 51 organizations which are scheduling programs for the Centennial. All types of meetings are planned and literature with long-range objectives, aimed at both children and adults, is being contemplated. Mr. Chandler reported that the two foremost problems at present were adequate financing of the Centennial and preparation of the Convocation.

There was general discussion and more emphasis on the desirability of having the unity problem settled in time for possible adoption of the ultimate plan during the Convocation.

Income-Tax Revision

A meeting held in January of groups interested in securing an amendment to the present income-tax law to make provision for establishment of retirement benefits by self-employed professional people and others, was reported by E. L. Chandler. Mr. Chandler reported that it was decided to set up a Coordinating Committee to co-ordinate activities of various interested groups. After discussion of the meeting, it was voted that EJC be represented on this committee by E. L. Chandler, with S. L. Tyler as alternate.

The EJC Annual Report for 1951 is now available. Copies may be obtained from the Engineers Joint Council, 29 West 39th Street, New York, N. Y. It consists of reports by 1951 EJC president James M. Todd, and by EJC committees on engineering manpower, international relations, and others. Part 2 of the report consists of the constitution and part 3 lists standing committees.

UNESCO Group Discusses Engineer's Peace Task

THE engineer's task in helping to win the struggle for peace, freedom, and advancement is not an easy one, Thorndike Saville, dean of the college of engineering, New York University, told Work Group 9 (Natural Scientists and Engineers) during the Third National Conference of the U. S. National Commission for UNESCO at Hunter College, New York, N. Y., Jan. 27–31, 1952.

He spoke at a session which discussed opportunities for scientists and engineers to contribute to peace through the United Nations system.

"If we are to be most helpful to others," Dean Saville added, "if we are to participate in a real collaboration by which the engineer of every land may bring greater health and happiness to that great body of citizens whom he serves, we must slow down a bit our 'do good' enthusiasm, we must take time to understand the peculiarities and problems of the other fellow, and we must make sure that he has time to absorb some of the background and philosophy of our system."

Dean Saville declared that only thus may we adjust our respective thinking to enable us to adapt what is useful to our respective problems.

Referring to "teams" from foreign countries who visit our industries, institutions, and farm

operations, as well as those from the U. S. who visit other countries, he said that neither group has taken time to understand traditions, habits, customs, educational methods, or laws of the countries visited. Methods of manufacture and education cannot be imposed universally or quickly.

"I believe we may accomplish most by taking time to show these engineers and others how we do things," he asserted, "and letting them decide how best to adapt our procedures to their conditions."

More than 2000 delegates attended the five-day conference, which had for its theme "The Citizen and United Nations." R. L. Goetzenberger, Fellow ASME, served as EJC representative. The conference brought together representative American leaders from the fields of education, science, religion, labor, government, and many others. Some participated as representatives of organized citizens groups and professional associations, others as individuals. But all came motivated by the objectives laid down in the broad conference plan, to consider the opportunities, obligations, and resources of a responsible citizenry for the eventual solution of international problems through participation in world affairs.

Report of Exploratory Group to Consider the Increased Unity of the Engineering Profession, December, 1951

Section A—General Conclusions

Introductory Historical Statement: The "Exploratory Group" was formed by the invitation of Engineers Joint Council, sent under date of June 8, 1949, to 16 of the major engineering societies of the United States. Each society was invited to designate a representative to attend a meeting to explore the desirability and practicability of increasing the unity of the engineering profession.

The Exploratory Group first met Oct. 20, 1949, and has met from time to time since. Also, there have been numerous meetings of its Planning Committee.

At a meeting on Dec. 16, 1950, the Exploratory Group adopted for the purpose of discussion an extensive report prepared by the Planning Committee. This report included descriptions of four different plans for establishing a "unity organization."[1] Thirty-three hundred copies of this report have been distributed among the officers and other representatives of the 15 societies finally constituting the Exploratory Group. It has been the basis for wide discussion during the past twelve months of the various problems involved in bringing about increased unity of the engineering profession.

On Sept. 28, 1951, the Exploratory Group received from its members oral reports of the results of these discussions. The reports indicated a very general agreement among engineers that immediate steps should be taken to achieve increased unity. As was to be expected, there were differences of view as to the best form of organization for this purpose. However, after full discussion, a majority of the members present voted:

That a report be prepared including a recommendation from the Exploratory Group to its constituent societies and to EJC to the effect that a unity organization be organized first by the development of EJC along the general lines of Plan A,[2] and suggesting further steps to be studied by the unity organization after the completion of the first step.

It was further voted that Mr. Osborne be requested to draft the proposed report, to be circulated to the members of the Exploratory Group for comment, and then to be submitted for action at a subsequent meeting of the Exploratory Group.

At its meeting on Dec. 15, 1951, the Exploratory Group adopted this report as its recommendation to its constituent societies and to the Engineers Joint Council. It does this with a conviction that the steps here proposed will be supported by a large majority of members of the engineering profession and that they will lead toward an increased unity which will be beneficial to the profession and to the community at large.

General Conclusions: The general conclusions of the Exploratory Group are as follows: (1) It is desirable that the engineering profession establish a unity organization which will be able to advance the unity of the profession and the service of the profession to the nation. (2) The unity organization should be formed by the modification and development of a present organization or by the integration of two or more present organizations rather than by the establishment of an entirely new organization. (3) The unity organization should initially include the participation of a majority of the national engineering societies represented in the Exploratory Group. (4) There are a number of important questions regarding the form and activities of the unity organization and its relation to other engineering bodies on which there are differences of opinion within the profession. Accordingly, it is desirable that the unity organization be launched in the simplest possible way and that these questions be studied and determined by the unity organization itself rather than by the Exploratory Group or any other temporary group. (5) To bring about this first simple step the Exploratory Group recommends to Engineers Joint Council that it invite all constituent societies represented in the Exploratory Group to become constituent societies of the Council. (6) The Exploratory Group recommends further that, coincident with this invitation, Engineers Joint Council modify Article II—"Membership" of its Constitution in such a way as to provide for membership on the Council by representatives

[1] Throughout this report the term unity organization is used for convenience but with no intention of suggesting this as a name for any organization which might result from this activity.

[2] "This plan contemplates the expansion of EJC to include other engineering societies which are eligible under the present constitution of EJC." From the December, 1950, Report of the Exploratory Group.—EDITOR.

Societies Represented in and Members of the Exploratory Group

American Association of Engineers, J. H. Griffin, chief engineer, Board of Transportation of City of New York, New York, N. Y.

American Institute of Chemical Engineers, L. W. Bass, U. S. Industrial Chemicals, Inc., New York, N. Y.

American Institute of Electrical Engineers, T. G. LeClair, chief electrical engineer, Commonwealth Edison Company, 72 West Adams St., Chicago, Ill.

American Institute of Mining and Metallurgical Engineers, J. L. Head, Anaconda Copper Company, 25 Broadway, New York, N. Y.

American Society for Engineering Education, Thorndike Saville, College of Engineering, New York University, New York, N. Y.

American Society of Civil Engineers, C. S. Proctor, 420 Lexington Ave., New York, N. Y.

American Society of Heating and Ventilating Engineers, L. E. Seeley, University of New Hampshire, Durham, N. H.

The American Society of Mechanical Engineers, E. J. Kates, 415 Lexington Ave., New York, N. Y.

American Society of Refrigerating Engineers, B. H. Jennings, mechanical-engineering department, Northwestern University, Evanston, Ill.

American Water Works Association, H. E. Jordan, American Water Works Association, 521 Fifth Ave., New York, N. Y.

Illuminating Engineering Society, S. B. Williams, Sylvania Electric Products, Inc., 1740 Broadway, New York, N. Y.

Institute of the Aeronautical Sciences, S. P. Johnson, director, Institute of the Aeronautical Sciences, 2 East 64th St., New York, N. Y.

Institute of Radio Engineers, B. E. Shackelford, RCA Building, Room 1242, 30 Rockefeller Plaza, New York, N. Y.

National Society of Professional Engineers, Alex Van Praag, Jr., Warren & Van Praag, Inc., 253 South Park St., Decatur, Ill.

The Society of Naval Architects and Marine Engineers, J. H. King, The Babcock & Wilcox Company, 85 Liberty St., New York, N. Y.

R. E. Dougherty, consulting engineer, 101 Park Avenue, New York, N. Y., president, Engineers Joint Council, 1949.

H. S. Osborne, *secretary;* chairman, EJC Committee on Unity of the Engineering Profession; chief engineer, American Telephone and Telegraph Company, 195 Broadway, New York, N. Y.

of the constituent societies appointed or elected for the purpose, and to provide for a number of representatives from each society, ranging from one to three. This recommendation is developed in more detail in Section B of this report. (7) The Exploratory Group recommends to the constituent societies of the Group that they accept the invitation of EJC and become constituent societies of that body. (8) Following these first steps, the Exploratory Group recommends that the enlarged Engineers Joint Council give further study to the matters discussed in Sections C, D, and E of this report and take appropriate action on each of these matters.

Section B—Initial Changes in Provision Regarding Membership in the Constitution of Engineers Joint Council

It is recommended that coincident with the invitation to the engineering societies represented in the Exploratory Group to join Engineers Joint Council, the constitutional provision regarding the members of the Council be so modified that such members shall be representatives of the constituent societies elected or appointed for the purpose and shall vary in number from one to three in each society depending upon size. This can be brought about by changing Article II, Section 1a, of the constitution to read as follows:

The Council shall comprise representatives elected or appointed by the constituent societies. Each society shall designate one representative for each 10,000 members (or fraction thereof) qualified to vote for national officers, with the qualification that no society shall have more than three representatives.

In accordance with this provision the Council would have the following numbers of representatives if all associations represented in the Exploratory Group become members of EJC:

Organization	*Voting members*[1]	*No. of Representatives on EJC Council*
American Association of Engineers	6078	1
American Institute of Chemical Engineers	4031	1
American Institute of Electrical Engineers	41,893	3
American Institute of Mining and Metallurgical Engineers	17,234	2
The American Society for Engineering Education	7500	1
American Society of Civil Engineers	32,901	3
American Society of Heating and Ventilating Engineers	5858	1
The American Society of Mechanical Engineers	37,000	3
American Society of Refrigerating Engineers	4720	1 (9/1/51)
American Water Works Association	8400	1

[1] As of Oct. 1, 1951, except where otherwise indicated.

(*Continued from first column*)

Organization	*Voting members*[1]	*No. of Representatives on EJC Council*
Illuminating Engineering Society	7166	1
Institute of the Aeronautical Sciences	4379	1
Institute of Radio Engineers	8231	1 (9/1/51)
National Society of Professional Engineers	24,213	3
The Society of Naval Architects and Marine Engineers	5420	1
Total		24

Section C—General Objectives

Objectives: The objectives of Engineers Joint Council are well stated in Article II, Section 2 of the Consitution. The Exploratory Group suggests consideration of adding to this statement of purposes. To assist in this the Group offers the following illustrative objectives which have been formulated in connection with its consideration of the matter. The first three of these are substantially those which now appear in the Constitution of EJC.

(*a*) To advance the general welfare of mankind through the technical knowledge and creative ability of the engineering profession.

(*b*) To promote co-operation among the various branches and groups of the engineering profession.

(*c*) To develop sound policies respecting public affairs in which engineering is an important factor.

(*d*) To stimulate engineers to take their proper place—individually and collectively—in public affairs.

(*e*) To enhance the recognition of engineering as a profession.

(*f*) To maintain high professional standards among engineers.

(*g*) To advance the standards of engineering education.

(*h*) To further the professional progress of young engineers.

(*i*) To assist its affiliated societies to aid and encourage the advancement of the theory and practice of engineering.

Scope of Activities: The scope of activities of the unity organization will, of course, at all times be determined by the desires of its members. It is recommended that the constituent societies recognize the unity organization as the major organ for co-operative work between them. However, this does not require the constituent societies to give up any of their present activities or their co-operation through other channels except as and when they find this to be desirable.

Within its field of activity the unity organization should deal directly with government agencies and with others as a representative of the engineering profession.

The unity organization should have its own staff, in order to fulfill successfully the responsibilities which the constituent societies will wish to entrust to it.

Without in any way suggesting the initial scope of activities, the Exploratory Group submits for information the following specific purposes developed in its discussions, which it suggests should come up for consideration from time to time in the unity organization, and in determining its relation to ECPD and other co-operative activities.

(*a*) To foster the relations of the engineering profession with other professions and with the sciences.

(*b*) To guide the co-operative activities, within its scope, among the various national engineering societies.

(*c*) To correlate the activities, within its scope, of regional, state, and local engineering and quasi-engineering organization.

(*d*) To assist in co-ordinating student chapters of engineering societies.

(*e*) To assist governmental units in matters referred by these units to the engineering profession.

(*f*) To express the views of the engineering profession on public questions with an engineering aspect.

(*g*) To analyze and express opinion on proposed or pending legislation on which the engineering viewpoint can be of value.

(*h*) To formulate criteria for colleges of engineering and to help in other ways to develop the educational and vocational orientation of young men wishing to become engineers.

(*i*) To study the economic status and employment of engineers.

(*j*) To increase public recognition of the achievements of engineering.

Section D—Major Questions to Be Considered by a Unity Organization

The Exploratory Group regards the following matters of paramount importance for determination if a unity organization is to be established on an adequate basis and to function successfully. Therefore, it is recommended that in the invitation of EJC to additional societies to affiliate with the Council, it be indicated that the following matters will be placed before the expanded EJC for prompt consideration.

Membership—National Engineering Societies: Since the unity organization is intended to represent all engineers, it is desirable that the constitution include a statement of the standards to be met by a national engineering society to make it eligible for consideration for membership.

Requirements for membership are now stated in Article II, Section 3, of the EJC constitution. It is recommended, however, that consideration be given to revising this so that the qualification would depend upon: (1) The professional qualifications as engineers of the members of the society. (2) Minimum size of membership as a qualification for voting membership in the unity organization.

Membership—Regional Societies and Councils: The Exploratory Group believes that affiliation with the unity organization of regional, state, and local engineers' societies and councils is important for the organization fully to carry out its responsibilities as a general representative of the engineering profession. This subject is very complicated because of the

interrelationship of the local and regional societies and their relation to the national engineering societies and because of the existence in some areas of competing regional groups.

It is hoped that the integration of co-operative effort at the national level evidenced by the development of the unity organization will enable that organization to establish increased unity and order in the relationships between regional, state, and local groups. It is recommended that the unity organization work upon this problem with sustained vigor, patience, and understanding.

Membership—Individuals: The Exploratory Group believes that provision in the unity organization for some form of membership of individuals is an important and perhaps necessary element of strength. This point of view is expressed also in some of the reports of the views of the constituent societies. On the other hand, there is no unanimity of view as to the nature of and qualifications for such membership.

It is recommended that this matter be given serious study by the unity organization. Section E of this report presents a discussion of the principal factors bearing on this matter as they have come before the Exploratory Group.

Financing: The expenses of the unity organization will depend upon the scope of its activities which in turn will determine the necessary size of its staff. Assurance of the maintenance of an income to support the program of activities decided upon at any time is naturally a fundamental necessity. The means of doing this will depend in part upon the decisions made regarding membership, particularly whether or not dues-paying individual members are to be included as a part of the organization. The Exploratory Group believes that the contributions which the constituent societies may make to the cost of operation of the unity organization should be in proportion to the numbers of members of these societies qualified to vote.

Relationship to Engineers' Council for Professional Development: The scope of activities will be influenced by a determination of the relationship which should exist between the unity organization and Engineers' Council for Professional Development. There should be no duplication of effort or activity. It is the view of the Exploratory Group that the interests of the profession would be advanced by the integration of ECPD as a department of the unity organization. Properly carried out, it should be possible to bring about such an integration without losing the impetus which ECPD now has as an active and effective organization.

Relationship to National Society of Professional Engineers: The initial step of the unity organization here proposed places the National Society of Professional Engineers on the same footing as the other societies represented in the Exploratory Group.

However, one of the plans studied by the Exploratory Group and included in their report of Dec. 16, 1950, contemplates a type of organization in which NSPE, with appropriate modifications, would be merged with EJC to form the unity organization.

It is recommended that careful study be given to the relationship between the activities of NSPE and those of EJC as a whole with a view to working out the most harmonious and effective relationship.

Name: It has been suggested that the present name "Engineers Joint Council" might be changed to advantage.

Section F—Membership of Individuals in Unity Organization

In the discussion of the advantages and disadvantages of a provision for membership by individuals in the unity organization, three general bases for such membership have been considered: (1) Automatic Membership. All members of the constituent societies would be considered automatically to be members of the unity organization. In an alternative this might apply only to all members in certain selected grades of membership. (2) Voluntary Membership—Broad Base. All members of the constituent societies would be eligible to be candidates for membership in the unity organization—action by the organization being necessary for their election. Eligibility might be limited to certain grades of membership, for example, to all voting members of the constituent societies. As an alternative, members meeting the qualification for Junior Membership in the founder societies (in AIEE the corresponding grade is Associate Membership) or higher grades would be eligible. This would give a base of eligible members of approximately 200,000 (without correction for duplications). (3) Voluntary Membership—High Professional Standards. In this form of membership, members of the constituent societies in grades of membership requiring a high degree of professional competence and more than five or 10 years' engineering experience would be eligible. This would correspond, in general, to the grade of Member in the Founder Societies. About 100,000 engineers would be eligible.

In the discussions of this matter in the Exploratory Group, it is agreed that whether or not there is a later provision for individual membership, the constituent societies should initially control the operations for the unity organization.

The advantages of provision for individual membership in the unity organization suggested by some members of the Exploratory Group include the following: (1) It would enlist maximum personal interest of the engineers in the activities of the unity organization. (2) Membership by individuals would provide a mark of professional recognition which should be a strong element in furthering the unity of the profession. This is particularly true with the type of membership indicated in paragraph 3 above and progressively less with the types of membership of paragraph 2 and paragraph 1, respectively. (3) It provides a stable basis for the support of the unity organization without burdening the national engineering societies.

The disadvantages of provision for individual members which are suggested by some members of the Exploratory Group include the following: (1) The possibility that the individual members as such would demand a voice in the government of the unity organization and that this might in the long run tend toward a reduction in the control of the organization by the constituent societies. (2) The possibility that the greater facility of raising financial support, represented by the individual dues, may result in a larger program of activities of the unity organization than otherwise and that this may react to the disadvantage of the constituent societies.

The form of organization which would result from having complete control in the hands of the constituent organizations and major financial support coming from voluntary dues-paying individual members is not novel but has been used with success by others. An example of this form of organization is the American Association for the Advancement of Science which was formed more than 100 years ago. This Association consists of 218 affiliated or associated scientific organizations (including several engineering societies) and about 45,000 individual members. Ninety per cent of the members of the governing body are elected or appointed by the affiliated societies. The financial support of the Association comes almost wholly from the individual members.

Minority Report—Submitted by Alex Van Praag, Jr., Representative of National Society of Professional Engineers

General Statement: Any recommendation for a unity organization for the engineering profession should have the support of a large majority of the engineer members represented by the participating societies. This direct expression from engineer members of our profession has only been accomplished to date in a small area of the profession.

Discussion and co-operative efforts should, therefore, be continued to educate every professional engineer in this country in the details involved in a unity organization before attempting a conclusion on the type of unity organization to be recommended.

The nonendorsement of even a single large group should be overcome before a unity organization is decided upon.

Major Items Not Yet Resolved: If and when a specific plan is proposed and recommended, that specific plan ought to first have resolved many of the important problems which are yet left quite vague or undetermined. The discussions of the Exploratory Group have not been concerned to date with solving all the problems which are recognized as problems of magnitude. Such procedure was entirely proper, but if a specific plan is to be recommended at this time, such specific plan must first have resolved important issues involving both principle and detail. There are a number of overlapping objectives and services between the proposed unity organization and several societies now represented in the Exploratory Group. Societies thus affected will be rightly concerned as to the effect the unity organization will have on their activities.

Individual Membership: The deliberations of the Exploratory Group over a period of more than two years have shown a majority of the members as preferring a unity organization based upon a democratic, individual participation type of membership. This appears to be

fundamental to a unity organization of a type that will long endure. The December, 1950, report of the Exploratory Group clearly provided that:

"Provisions should be made for the membership of individuals in the unity organization. Such members should pay individual dues to the unity organization."

This declaration was one of the agreed principles to be inherent in the unity organization. Adoption of the present proposed report does not provide for this previous determination and declaration of policy. The adoption of the present report then is quite inconsistent with the determination to provide for individual-membership participation.

Authority for Action: The authority for action on the part of the unity organization must be clearly defined. Unless the unity organization is given authority to act on behalf of the engineering profession, with provision made for a binding decision to be reached by democratic processes, support for this decision not being optional with the participating societies, a unity organization cannot be successful or enduring. The unity organization must be given final and complete authority to act on behalf of the profession. There cannot be a system of participation or nonparticipation at the choice of each of the participating societies, either in support of the policies or the financing of the unity organization. If one or more major societies withdraw from the council, what happens to the organization, or, more important, the unity in the profession?

Organization Beyond National Level: To be successful, the unity organization must be organized on a three-level basis or at least at other than the national level only. It is evident that the unity organization must have grass-roots representation if it is to be effective. The problems of the profession are such that there must be co-ordination and liaison for all problems of the engineer which exist at state and local as well as the national level. For example, legislation and government representation, agreed to be a principal interest of the unity organization, is affected by action at individual, local, state, and national levels.

Financing: The extent and manner of financing the national unity organization and its activities should be fully resolved before a specific plan is recommended. An intelligent vote on the adoption of a final plan demands an adequate prior determination of the principles and extent of the financing. Such is not provided in the proposed report.

Conclusions: With the above expression of certain principles and policies which, in turn, have not been resolved to date in the deliberations of the Exploratory Group, many believe that recommendation for a unity organization at this time is immature.

Elements of the profession should be encouraged to publicize and discuss through all means available to their respective societies the need for and the objectives of a unity organization upon which there seems to be no difference of opinion.

The subject should be pursued until there is developed a plan which will be acceptable not only to the executive direction of the participating societies, but to a large majority of their individual members.

It is urged that no specific plan be fostered until first there shall be further discussions and education of the profession, and second a polled expression of opinion from members of the profession on which to base further implementation of the unity organization.

Thereafter, it would be appropriate, and only then, for the Exploratory Group to develop details for the unity organization and to recommend the adoption of a specific plan.

Pittsburgh Mechanical-Engineering Conference to Stress Conservation

William Penn Hotel, March 18–19, 1952

CONSERVATION of Materials, Manpower, and Time, the theme of the two-day mechanical-engineering conference to be held in Pittsburgh, Pa., March 18-19, 1952, will be amplified in session by the discussion of such topics as strategic metals—their conservation or the use of alternatives; technical manpower in the years ahead; and increased productivity. With so challenging and appropriate a theme and such interesting and thought-provoking topics, engineers in attendance from this extremely industrialized tri-state area, will be assured of a successful conference.

H. N. Muller, Jr., and J. T. Bunting, vice-president and secretary of the Pittsburgh Section, ASME, are in charge of the ASME contributions to the program of the conference. They in turn are co-operating with representatives of the American Materials Handling Society, the American Society of Heating and Ventilating Engineers, the American Society of Lubricating Engineers, American Society of Refrigerating Engineers, National Association of Corrosion Engineers, and Engineers Society of Western Pennsylvania to help make this an even bigger and better conference than last year's.

The conference banquet will be held Tuesday evening at 7:00 p.m. at the William Penn Hotel and the ladies are cordially invited to attend. The dinner speaker will be P. M. McKenna, Mem. ASME, president of Kennametal, Inc., Latrobe, Pa., and R. J. S. Pigott, president ASME, will be toastmaster

A panel discussion on strategic metals—their conservation or the use of alternatives—opens the meeting to be followed by sessions at which papers on technical manpower and increased productivity will be presented. An inspection trip to the Gulf Research and Development Laboratory at Harmarville, Pa., is planned.

The tentative program follows:

TUESDAY, MARCH 18

9:30 a.m.

Panel: **Strategic Metals; Their Conservation, or the Use of Alternates**

Chairman: G. A. Shoemaker, vice-president, Pittsburgh Consolidation Coal Company

Members of the Panel:

H. C. Amstberg, manager, metallurgical engineering, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Frank LaQue, director of research, International Nickel Company, New York, N. Y.

G. A. Roberts, metallurgist, Vanadium Alloys, Latrobe, Pa.

R. B. Smith, vice-president, M. W. Kellogg Company, New York, N. Y.

J. A. Willard, chief development engineer, Aluminum Company of America, Pittsburgh, Pa.

To be announced, representative, National Production Authority, Washington, D. C.

2:00 p.m.

Technical Manpower in the Years Ahead

Chairman: H. E. Longnecker, dean, Graduate School, University of Pittsburgh.

The Engineering Manpower Commission—Programs and Progress, by *T. A. Marshall, Jr.*, executive secretary, Engineering Manpower Commission of Engineers Joint Council

Implications of Our Manpower Mobilization, by *Gen. C. S. Dargusch*, attorney at law, Columbus, Ohio, and formerly Deputy Director, National Selective Service Headquarters

7:00 p.m.

Banquet

Chairman: W. S. Major, Pittsburgh Section, ASME

Toastmaster: R. J. S. Pigott, President ASME

Speaker: Phillip M. McKenna, president, Kennametal, Inc., Latrobe, Pa.

WEDNESDAY, MARCH 19

9:30 a.m.

Increasing Productivity

Chairman: R. E. Sheffer, assistant superintendent, Aluminum Company of America, New Kensington, Pa.

Wages and Incentive Plans, by *M. W. Lewis*, chief industrial engineer, U. S. Steel Company, Pittsburgh, Pa.

Material Handling, by *Frank Wier*, superintendent of transportation, Timken Roller Bearing Company, Canton, Ohio

1:00 p.m.

Inspection Trip

Gulf Research and Development Laboratory, Harmarville, Pa.

NBS Symposium on Resistance Strain Gages

THE NBS Symposium on Resistance Strain Gages, held at the National Bureau of Standards on Nov. 8–9, 1951, in co-operation with the Office of Naval Research, brought together about 300 engineers and physicists, representing most of the engineering industries and government and university laboratories. The large attendance at the symposium, the eleventh of a series marking the NBS semicentennial year, is evidence of the revolutionary impact that the resistance-wire strain gage has had on mechanical testing in this country during the past decade. It was only 10 years ago that a practical method was found for measuring the internal strain of a structure by utilizing the change in electrical resistance of fine wire bonded to it. The symposium was under the joint chairmanship of Dr. Walter Ramberg and W. R. Campbell of the NBS Mechanics Division.

Three of the 11 papers presented at the symposium dealt with the properties of the fine

wire in the resistance-wire strain gage itself. Particular attention was given to the change in resistance of the wire for strains beyond the elastic range of the wire material.

Seven of the papers were concerned with applications of the wire strain gage in industry and in the laboratory. One of the papers described several applications of the bonded wire strain gage, in which the wire is cemented to the metal.

Present practice in the application of wire strain gages in Europe was described. The application of the bonded wire strain gage in the construction of dynamometers, to calibrate testing machines of the largest capacity for the first time over their full range, was described. Their application to measure strain inside concrete during freezing and thawing tests and to measure strain at the surface of concrete specimens under impact load was reported. The development of the unbonded wire strain gage as a basic element for measuring force, pressure, displacement, and acceleration as well as strain was covered.

A paper was presented on the change in electrical resistance with strain imposed on evaporated films of nine different elements. Among these, carbon films showed greatest promise because of their extremely high output coupled with approximate linearity for strains up to 15 per cent. Attention was called to the first resistance strain gage to see widespread use.

W. C. HEATH CITED BY ARMED SERVICES

(Unification of the Armed Services was demonstrated in San Diego, Calif., Dec. 28, 1951, when ranking officers honored William C. Heath, Mem. ASME, chief design engineer of Solar Aircraft Company, with a citation for "patriotic service rendered to the Technical Industrial Intelligence Committee, Joint Chiefs of Staff, during World War II." *Left to right:* Maj. Gen. W. B. Kean, USA, commander of the III Corps; Rear Adm. G. R. Henderson, USN, commander naval air bases, 11th and 12th Naval Districts; W. C. Heath; and Brig. Gen. R. H. Ridgely, Jr., USMC, acting commander, San Diego Marine Recruit Depot.)

American Power Conference Offers Three-Day Program

Sherman Hotel, Chicago, Ill., March 26–28

THE first annual American Power conference will be held March 26–28, 1952, at the Sherman Hotel, Chicago, Ill. R. A. Budenholzer, Mem. ASME, professor of mechanical engineering at Illinois Institute of Technology, is conference director.

The meeting will be a continuation of the Midwest Power conference, which has been sponsored by Illinois Institute of Technology for 13 years in co-operation with nine midwestern colleges and universities, the Chicago Section, ASME, and the local sections of eight other national engineering societies. The Edison Association of Illuminating Companies and the Edison Electric Institute will join the list of co-operating groups. The name was changed because of the national significance of the previous power meetings.

Martin H. Kennelly, Mayor of Chicago, will address the opening meeting at 9:00 a.m. Wednesday, March 26. W. J. Grede, president of the National Association of Manufacturers, will be a luncheon speaker, Friday, March 28, at 12:15 p.m. Other prominent engineers and industrialists will address the meetings.

Some of the technical sessions of particular interest to mechanical engineers follow:

WEDNESDAY, MARCH 26

Thermal Efficiency and Design of High-Temperature and Reheat Turbine-Generator Units, by *T. R. Carlson*, manager, application engineering department, Westinghouse Electric Corporation, South Philadelphia, Pa.

Controls of Modern Steam-Turbine-Generator Units, by *C. F. Wilson*, engineer in charge, large turbine design, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

The Development and Application of Water-Tube Package Steam Generators, by *N. O. Kirkby*, executive engineer, Vapor Heating Corporation, Chicago, Ill.

Coal-Dust Control With Liquid-Diffusion Compounds, by *G. A. Mau*, vice-president, Johnson March Corporation, Philadelphia, Pa.

Trends in Modern Central-Station Boiler Design, by *H. B. Wallace, Jr.*, manager, steam sales, Foster Wheeler Corporation, New York, N. Y.

Considerations in the Design of Large Central-Station Boilers, by *W. A. Rowand*, chief engineer, The Babcock & Wilcox Company, New York, N. Y.

Human Relations in Personnel Practice, by *S. C. Casteel*, assistant manager, East St. Louis and Interurban Water Company, East St. Louis, Ill.

Experiences and Results of Personnel Training Courses, by *O. P. Stamlad*, supervisor, training division, Union Electric Company of Missouri, St. Louis, Mo.

Present and Future of Personnel Training in the U. S. A., by *W. F. Patterson*, director, Bureau of Apprenticeship, United States Department of Labor, Washington, D. C.

THURSDAY, MARCH 27

Recent Developments in High-Pressure Boiler Feed Pumps, by *I. J. Karassik*, application engineer, Worthington Pump and Machinery Corporation, Harrison, N. J.

Demand Performance Fluid Drive in the Modern Plant, by *Ben Ragland*, manager, hydraulic-coupling division, American Blower Corporation, Detroit, Mich.

The Multipurpose Columbia River Development Program, by *E. C. Hannum*, program co-ordinator, Bonneville Power Administration, Portland, Ore.

Kemano-Kitimat, Producer of Packaged Hydro-Power, by *F. L. Lawton*, chief engineer, power department, Aluminum Laboratories Ltd., Montreal, Que., Can.

Fundamental Designs and Design Considerations of Industrial Condensers, by *G. H. Putnam*, manager, condenser department, Ingersoll-Rand Company, New York, N. Y.

Condenser Circulating-Pump Intakes, by *W. W. Wiltmer*, design engineer, centrifugal pump department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

Design Features of the Oak Creek Station, by *O. J. Stallkamp*, assistant chief designer, Wisconsin Electric Power Company, Milwaukee, Wis.

The Joppa Steam-Electric Station, by *Ralph Moody*, executive vice-president, Union Electric Company of Missouri, and vice-president and director, Electric Energy, Inc., St. Louis, Mo.

Magnetic Amplifiers for Power Control, by *E. L. Harder*, consulting transmission engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa.

Servomechanisms in the Power Industry, by *M. A. Edwards*, manager of engineering, General Engineering Laboratory, Schenectady, N. Y.

FRIDAY, MARCH 28

Water-Tube Corrosion in British Power Stations, by *E. W. F. Gillham* and *R. S. Rees*, British Electricity Authority, London, England.

Study of Operating Costs of Large Slow-Speed Diesel Engines Versus Gas Turbines, by *J. Byron Sims*, Superintendent of Public Works, Grand Haven, Mich.

The Place of Lignite as a Fuel for the Middle West, by *Alex Burr*, director of research, North Dakota Research Foundation, and chief, Fuels Technology Division, Region V, U. S. Bureau of Mines, Bismarck, N. Dak.

The Processing of Coal, by *A. D. Singh*, director and president, Singh Company, Chicago, Ill.

Gas-Turbine Power-Plant Designs, by *T. J. Pais*, manager, locomotive and gas-turbine engineering division, Westinghouse Electric Corporation, Philadelphia, Pa.

Operating Experiences With Gas Turbines, by *Paul R. Sidler*, president, Brown Boveri Corporation, New York, N. Y.

Progress Report on the Coal-Fired Gas-Turbine Locomotive, by *J. I. Yellott*, director of research, Locomotive Development Committee, Bituminous Coal Research, Inc., Dunkirk, N. Y.

ASME Boiler Code Committee Plans Toronto Meeting With EIC

Royal York Hotel, Toronto, April 24-25

THE first meeting of the ASME Boiler Code Committee to be held in Canada will be at the Royal York Hotel, Toronto, Ont., on April 24-25, 1952, under the sponsorship of the International Council of The American Society of Mechanical Engineers and The Engineering Institute of Canada, of which O. W. Ellis, Mem. ASME, MEIC, of Toronto, is chairman.

The ASME Boiler Code Committee is composed of a group of technical specialists, some 22 in number, who have been meeting regularly under the auspices of ASME for many years. It has been their responsibility to establish and maintain the engineering standards applying to the manufacture, installation, and operation of all items of mechanical equipment which are subject to fluid pressure. These standards are now accepted generally throughout the United States and Canada as well as in many other parts of the world.

The Canadian Standards Association, of which W. R. McCaffery, MEIC, of Ottawa, is general manager, has maintained close liaison with this committee for some years in developing Canadian standards and specifications for the design and manufacture of power and heating boilers as well as unfired pressure vessels, piping, and accessories. They and representatives of all other interested groups of engineers, from both manufacturers and user companies, have been invited to attend this meeting to participate in the technical discussions.

IAS Honors Prominent Aeronautical Engineers at Annual Banquet

Wilson Calls U. S. Insured by Budget

AT THE Honors Night dinner of the 20th annual meeting of the Institute of Aeronautical Sciences, held at the Astor Hotel, New York, N. Y., Jan. 28, 1952, the principal speaker, the Hon. C. E. Wilson, Mem. ASME, Director of Defense Mobilization, asserted that the nation was suffering from an attack of "budgetitis" since President Truman requested $85 billion for the coming fiscal year. Mr. Wilson pointed out, however, that the fact is the nation is buying an insurance policy. Though the premiums are heavy, it would be the most tragic kind of folly to drop the policy. Total mobilization, he said, would disrupt our civilian economy, close down large segments in industry and business, and produce mountains of obsolescent weapons.

He further told the dinner guests that the extension of the three-year plan accorded with practical considerations, such as the limits on supplies of strategic materials.

Fellowships Conferred

The Institute conferred honorary fellowships, its highest grade of membership, on L. R. Grumman, chairman of the board, Grumman Aircraft Engineering Corporation, and J. H. Parkin, Mem. ASME, director, National Aeronautical Establishment of Canada. N. J. Hoff, Mem. ASME, was among the newly elected IAS Fellows.

Durand Museum to Be Established

Acting on behalf of the Durand Reprinting Committee, C. B. Millikan, director, Guggenheim Aeronautical Laboratory, California Institute of Technology, presented a sum of money for the establishment of the W. F. Durand Aeronautical Museum at the IAS Western headquarters building in Los Angeles, Calif. The fund was presented at the Honors Night dinner.

William Frederick Durand, past-president and Hon. Mem. ASME, the man for whom this museum is named, is professor emeritus, mechanical engineering, Stanford University. Dr. Durand, dean of America's aeronautical engineers, is well known in international aeronautical circles for his many contributions, but of these perhaps best known is his six-volume classic, "Aerodynamic Theory," of which he is editor in chief.

Petroleum Research Authority Elected SAE President for 1952

D. P. BARNARD, 4TH, Mem. ASME, research co-ordinator, Standard Oil Company (Indiana), Chicago, Ill., was elected president for 1952 of the Society of Automotive Engineers. The announcement was made at the society's annual business meeting, held Jan. 15, 1952, at the Hotel Sheraton-Cadillac, Detroit, Mich. Dr. Barnard succeeds Dale Roeder, Ford Motor Company, who served as SAE president during 1951.

Twelve 1952 vice-presidents, each heading an SAE Professional Activity, also were installed. Their elections, like that of the president, resulted from a mail vote of the membership.

Dr. Barnard has dedicated years to the matching of fuels and engines, winning the SAE Horning Memorial Award in 1949 for distinguished active service in this field.

Harvey F. Mack Honored for Service to the Community

HARVEY F. Mack, president, Mack Printing Company, Easton, Pa., ASME printer of MECHANICAL ENGINEERING for 32 years, was awarded the Kiwanis International Legion of Honor in recognition of his attributes—exemplary citizen, outstanding industrialist, and God-fearing churchman. At a testimonial luncheon at Hotel Easton, Mr. Mack also was declared a "citizen of Easton emeritus" by Mayor R. W. Morse.

The Kiwanis award, first of its kind to be made by the Easton club, was presented to the head of the Mack Printing Company in recognition of his many years of service to the community and his 33 years of Kiwanis membership.

As a collateral award, Mr. Mack received a pin in honor of 11 years of perfect attendance at Kiwanis meetings. He is a charter member and past-president of the Easton club.

Spokesmen and delegations from community enterprises in which he has had a part were present, including his own firm, the Community Chest, YMCA, Easton Area Chamber of Commerce, and First Methodist Church.

113 American Standards Approved by ASA

THE American Standards Association approved 113 American Standards in 1951, bringing the total of new and revised American Standards to 1181, Vice-Admiral G. F. Hussey, Jr., announced in a managing director's report on 1951 activities.

While most of the 113 new American Standards are in technical fields, many are of general consumer and public interest. Among these are the Manual of Accident Prevention in Construction, A10.1-1951; Approval Requirements for Central Heating Gas Appliances, Z21.13-1951; Approval Requirements for Gas Unit Heaters, Z21.16-1951, Listing Requirements for Automatic (Gas) Pilots, Z21.20-1951; and the like. He further stated that 369 projects are now being developed under ASA procedures by sectional subcommittees.

The ASA also is participating in 23 projects within the procedures of the 33-nation International Organization for Standardization (ISO).

ASA Honors NBS

THE National Bureau of Standards was recently honored by the American Standards Association on the occasion of the Bureau's 50th anniversary. A feature of the ASA's annual meeting, at the Waldorf-Astoria, New York, N. Y., Oct. 22, 1951, was the presentation of a scroll congratulating the Bureau "on a half-century of service in the public interest and in the improvement of the standard of American life."

Twelve Regional Student Conferences for 1952

FROM February through May, 134 student branches of The American Society of Mechanical Engineers will present their most-likely-to-succeed future engineers, who were selected in local papers competitions, at 12 Regional Student Conferences, held annually to determine the regional winners of the prize papers.

More than 2000 student members attended the conferences—"little" annual meetings—last year. Their enthusiastic participation and interest in engineering, the men engaged in the profession who addressed their meetings, and their fellow students helped make these conferences the huge successes they were.

Every effort is made to have the conferences in as centrally located a college or university as possible to minimize the travel distance and to insure maximum attendance. In the East the regions are geographically small and one conference is generally sufficient. In the West, however, where the regional divisions are vaster, two or three conferences are required. Although the student conferences are intended to be the climax of the scholastic student-branch year, this year the Southern Tier, Region VIII, will lead off with the first conference to be held at the University of Texas, Feb. 29-March 1. Other conferences will be held in conjunction with Regional Administrative Conferences. A list of the student conferences is printed elsewhere on this page.

The blueprint for the student conferences is similar to that of Society national meetings. The registration period is followed by technical sessions, at which time the papers are entered in competition, luncheons, and dinners. The social evenings take on local flavor—dances, barbecues, or a "wingding" special style. The local industries, in co-operation with the host branch and the ASME Section, usually arrange inspection trips.

The Society, in part, defrays the travel expenses from the student branch to the conference and further encourages keen competition by granting each conference $100 in prize money. The Old Guard of the Society also contributes $10 as a prize to each conference.

Members of ASME, who in the past have served as judges, have had difficulty choosing the winners; all the papers were of such high caliber.

For summaries of the prize-winning papers at the 1951 Student Conferences, see pages 862, 864-866 of the October, 1951, issue of MECHANICAL ENGINEERING.

Lubrication Activity

THE Professional Divisions Committee has approved the organization of a new Lubrication Activity to comprise research, design, builders, users, and lubricant supplies.

It is important that every member interested in this activity attend the organization meeting at ASME Headquarters, 29 West 39th Street, New York, N. Y., at 9 a.m., Thursday, March 20, 1952.

ASHVE Announces 1952 Officers

ERNEST Szekely, Mem. ASME, president, Bayley Blower Company, Milwaukee, Wis., was elected 1952 president of The American Society of Heating and Ventilating Engineers at the society's 58th annual meeting, Hotel Statler, St. Louis, Mo.

Other officers elected were: First vice-president, Reg. F. Taylor, consulting engineer of Houston, Texas; second vice-president, L. N. Hunter, Mem. ASME, vice-president of research, National Radiator Company, Johnstown, Pa.; treasurer, J. Donald Krocker, Mem. ASME, consulting engineer, Portland, Ore.

F. P. WILLCOX HONORED FOR NEW INVENTION

(*Left:* Frederick P. Willcox, Mem. ASME, vice-president and research director, Fairchild Camera and Instrument Corporation, Jamaica, N. Y., shows a Rapidyne aerial camera shutter, with 4½-in. lens opening, to Col. G. W. Goddard, chief of the Air Force Photographic Laboratory. Mr. Willcox received the 1952 Photogrammetric Award for inventing the new camera shutter. The innovation is now being used with great success by the Air Force in Korea.)

First NMC Discussion Luncheon Meeting Outside New York

H. F. SMIDDY, Mem. ASME, vice-president of NMC, and vice-president of the General Electric Company, presided at the first National Management Council Luncheon Discussion Meeting to be held outside New York, N. Y. The meeting was held at the Blackstone Hotel in Chicago, Ill., Jan. 28, 1952. He spoke on "Management's International Opportunities." This luncheon inaugurated a new NMC policy in bringing discussions of international management problems and questions to NMC members and those of affiliated societies, residing outside of New York, N. Y.

1952 ASME Regional Student Conferences

	Region	*Host*	*Place*	*Date*
I	New England	University of Massachusetts	Amherst, Mass.	May 2-3
II	Eastern	(Host, place, and date to be announced)		
III	Alleghenies	University of Maryland	College Park, Md.	April 18-19
IV	Southern	North Carolina State College Duke University (Concurrent with Regional Administrative Committee Meeting)	Raleigh, N. C.	March 30-31
V	Midwest	University of Akron	Akron, Ohio	April 28-29
VI	Northern Tier	Michigan College of Mining and Technology	Houghton, Mich.	May 12-13
VI	Southern Tier	Rose Polytechnic Institute	Indianapolis, Ind.	May 8-9
VII	Pacific Northwest	University of Idaho	Moscow, Idaho	May 1-3
VII	Pacific Southwest	Stanford University	Stanford, Calif.	May 16-17
VIII	Northern Tier	University of Arkansas	Fayetteville, Ark.	May 5-6
VIII	Rocky Mountain Tier	Rocky Mountain Section ASME (In conjunction with Region VIII RAC Meeting)	Denver, Colo.	April 29-30
VIII	Southern Tier	University of Texas	Austin, Texas	Feb. 29-March 1

ASME Calendar of Coming Events

March 24–26
ASME Spring Meeting, University of Washington, Seattle, Wash.
(Final date for submitting papers was Nov. 1, 1951)

June 15–19
ASME Semi-Annual Meeting. Sheraton-Gibson Hotel, Cincinnati, Ohio
(Final date for submitting papers was Feb. 1, 1952)

June 19–21
ASME Applied Mechanics Division Conference, The Pennsylvania State College, State College, Pa.
(Final date for submitting papers was Feb. 1, 1952)

June 23–27
ASME Oil and Gas Power Division Conference, Hotel Statler, Buffalo, N. Y.
(Final date for submitting paper was Feb. 1, 1952)

June 26–28
ASME Applied Mechanics Division, West Coast Conference, University of California, Los Angeles, Calif.
(Final date for submitting papers was Feb. 1, 1952)

Sept. 8–11
ASME Fall Meeting, Sheraton Hotel, Chicago, Ill.
(Final date for submitting papers—May 1, 1952)

Sept. 8–12
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Cleveland Auditorium, Cleveland, Ohio
(Final date for submitting papers—May 1, 1952)

Sept. 22–24
ASME Petroleum Mechanical-Engineering Conference, Hotel President, Kansas City, Mo.
(Final date for submitting papers—May 1, 1952)

Oct. 30–31
ASME Fuels and AIME Coal Divisions Joint Conference, Bellevue-Stratford Hotel, Philadelphia, Pa.
(Final date for submitting papers—June 1, 1952)

Nov. 30–Dec. 5
ASME Annual Meeting Statler Hotel, New York, N. Y.
(Final date for submitting papers—July 1, 1952)
(For Meetings of Other Societies see page 252)

Columbia Basin Section Installed

THE Richland Group of the Inland Empire Section attained ASME Section status and is called the Columbia Basin Section. On November 26, 1951, Council acted favorably on the recommendation of Prof. S. H. Graf, vice-president ASME, Region VII, that this group be granted Section status. The action culminated the efforts of the membership of this group for a period of over four years to attain full recognition.

This action will result in the following concrete advantages to the membership within the area included in the new section (Kittitas, Klickitat, Yakima, Benton, Franklin, and Walla Walla Counties in Washington): Income of the new Section will be approximately four times that available to the Richland group during previous years; two regional delegates from the new Section will be sent to the Regional Delegates Conference at ASME expense each year.

Actions of the ASME Executive Committee

At a Meeting at Headquarters, Jan. 22, 1952

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on Jan. 22, 1952. R. J. S. Pigott, chairman, presided. In addition to Mr. Pigott, there were present: H. R. Kessler, T. E. Purcell, W. F. Thompson, of the Executive Committee; E. J. Kates, assistant treasurer; E. G. Bailey, past-president; H. E. Martin, director at large; C. E. Davies, secretary; and Ernest Hartford, executive assistant secretary.

Development Fund

It was reported by the Secretary that a total of $36,127 was collected to date in connection with the recent campaign for contributions from industry and ASME members on behalf of the Development Fund, of which $32,620 came from industry and $3507 from members. An additional amount of $5000 was authorized to continue the work of raising funds for the Development Fund.

Roy V. Wright Lecture

Selection was approved of Alfred H. Williams, president, Federal Reserve Bank of Philadelphia, Pa., as the Roy V. Wright Lecturer at the 1952 Annual Meeting in New York.

Calvin W. Rice Lecture

On recommendation of the Board on Public Affairs, the Council approved the selection of Dr. Ing. Piero Ferrerio, president, Societa Edison, Milan, Italy, as the Calvin W. Rice Lecturer at the 1952 Semi-Annual Meeting.

Research Committee

The Council authorized the execution of a proposed contract between the U. S. Department of the Navy and the Society, covering the fabrication of high-temperature, high-pressure steam test racks, one phase of a research and development program being sponsored by the Research Committee on High-Temperature Steam Generation.

Student Branches

Upon recommendation of J. T. Rettaliata, vice-president, Region VI, the establishment of a student branch at Bradley University, Peoria, Ill., was approved.

Certificates of Award

A special certificate of award was approved for Henry Parker Merriam, Hubbardston, Mass., in recognition of his 65 years of membership in the Society.

Certificates of award were approved for the following retiring chairmen of committees: K. P. Hanson, Constitution and By-Laws; Darrow Sage, Engineers Registration; A. W. Thorson, Meetings; W. P. Saunier, Organization; J. M. Lessells, Professional Divisions; John Haydock, Publications; H. W. Heinrich, Safety; and Granger Davenport, Standardization.

Certificates of award were also approved for the following retiring chairmen of Sections: F. H. Thomas, Buffalo; Q. Wellington, Central Illinois; J. J. Symons, Central Iowa; Herbert McClammy, Florida; and C. M. Warner, Waterbury.

Unity of Engineering Profession

A final report on a proposal for inaugurating greater unity in the engineering profession was submitted to the Council by H. S. Osborne, chairman of the Exploratory Group on Unity of the Engineering Profession. The Secretary was instructed to convey to Dr. Osborne the action of the ASME Council on June 10–11, 1951, approving the statement of opinion of the 1951 Regional Delegates Conference as the view of the ASME Council. Further action by the Council will await the action to be taken by the Engineers Joint Council.

Appointments

Appointments on committees and joint activities recommended by the Organizations Committee were approved.

The following presidential appointments were approved: Alex D. Bailey, reappointed as the ASME representative on the Charles A. Coffin - Gerard Swope Fellowships Committee (General Electric Educational Fund); Harry C. Bigglestone, inauguration of president, University of Arizona; J. T. Rettaliata, centennial convocation, Northwestern University; and A. W. Luce, Greater New York Safety Convention and Exposition.

Meeting With ASME Representatives

The Council scheduled its customary yearly meeting with ASME representatives on United Engineering Trustees, Inc., Engineering Foundation, and the Library, for February 18, at 6:30 p.m.

Demand for Engineers Increases

EVERY engineering senior who wants a job by graduation time can have it, according to Charles E. Wangeman, head of the Bureau of Placements at Carnegie Institute of Technology.

The demand for engineers is increasing while the supply is decreasing, said Mr. Wangeman. This year we expect to hear from at least 700 companies in regard to job opportunities. Although interviews do not start until February, 200 companies had already established definite consulting dates with our 760 seniors who will be qualified for technical and junior executive positions in business and industry. In 1951, 600 companies contacted Carnegie's graduating engineers. Of these firms, 250 sent personal representatives to recruit seniors on campus.

Salaries

Along with the demand for engineers, salaries have also gone up. Mr. Wangeman predicts an increase of 7 to 10 per cent this year over the starting salaries of last June's graduates.

"The average salary for last year's engineering graduates was $300 a month," said Mr. Wangeman. This year, the average salary for a Carnegie student with a BS degree in engineering will be $325, with starting salaries ranging from $285 to $400. Engineers with a doctorate degree can expect a minimum of $6000 a year to start.

Manpower Demand Nationwide

The companies that contact Carnegie Tech students represent a cross section from all over the United States. Not only the large corporations but the small firms as well are gobbling up the engineers faster than they can be turned out. Of last year's graduating class, the distribution of engineers ranged from 7 per cent who joined firms with 100 employees or less, to 40 per cent who joined companies with 25,000 or more employees.

One third of the engineers from the class of 1951 work with firms in Pittsburgh or the surrounding metropolitan area while the other two thirds are employed by various companies throughout the country.

The majority of last year's engineering graduates went into manufacturing industry. Electrical equipment, machinery, steel and nonferrous metals, chemical and allied products, and paper and printing attracted the largest number of Carnegie engineers.

60,000 Engineers Needed

However, Mr. Wangeman points out, because of the serious shortage of some 60,000 engineers and scientists at the present time, there is no longer such a thing as any special technological field leading another. All kinds of engineers are needed for every phase of the profession: all offer excellent pay and excellent opportunities.

W. H. OLDACRE, MEM. ASME (1892–1952)

(William H. Oldacre, president and general manager of D. A. Stuart Oil Company, Chicago, Ill., died suddenly on Jan. 18, 1952. In many avenues of ASME activities will his passing be marked. At the time of his death he was serving the Society as chairman of the General Committee, 1952 Fall Meeting to be held in Chicago, Ill., Sept. 8–11, 1952. He was also a member of the Medals Committee. In 1949 and 1950 he was chairman of the Nominating Committee; he was chairman of the Chicago Section, ASME, 1948–1949. As a result of his specialized professional interests, he was active on the Society's Research Committee on Cutting Fluids since 1934; and the Subcommittee on Threading of the Research Committee on Cutting Fluids, from 1946. He had been a member of the Research Committee on Metal Cutting Data and Bibliography since December, 1943.)

People

RENÉ DE VALLIERE, Zürich, Switzerland, received by proxy the Wallace Clark Award for distinguished contribution to scientific management in the international field. Dr. Frederick Cygas, Swiss Consul General, received the award for Professor de Valliere at the annual dinner meeting of the National Management Council held in the Plaza Hotel, New York, N. Y., Jan. 9, 1952.

Among the newly elected officers of the council were two members of ASME, H. F. Smiddy, general manager, air-conditioning department, General Electric Company, and E. H. Schell, professor in charge, department of business and engineering administration, M.I.T., to serve as vice-presidents.

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J. F. HENNESSY of Syska and Hennessy, Inc., has been re-elected president of The New York Association of Consulting Engineers for a second term. Other officers re-elected were B. R. Value, vice-president; W. D. Christie, Mem. ASME, secretary; and H. H. Bond, treasurer.

K. S. M. DAVIDSON, Mem. ASME, director, and B. V. Korvin-Kroukovsky, research professor of fluid dynamics of the Experimental Towing Tank, Stevens Institute of Technology, are among the 99 distinguished scientists recently elected Fellows of The New York Academy of Sciences.

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P. F. MARTINUZZI, Life Mem. ASME, Calvin W. Rice Lecturer, 1948, and internationally known authority on gas turbines, has been appointed to the faculty of Stevens Institute of Technology. Beginning with the spring semester Dr. Martinuzzi will teach both graduate and undergraduate work at Stevens. For the past two years he has been professor of mechanical engineering at Cornell University.

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HOMER ADDAMS, Mem. ASME, chairman of the board of the Fitzgibbons Boiler Company, Inc., New York, N. Y., and the only living charter member of the American Society of Heating and Ventilating Engineers, has been elected to receive the 1951 F. Paul Anderson Medal of the society, for "outstanding work in the field of heating, ventilating, and air conditioning."

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J. T. RETTALIATA, vice-president, ASME, Region VI, vice-president and dean of engineering at Illinois Institute of Technology, was named president of the Institute. Dr. Rettaliata succeeded H. T. Heald, Mem. ASME, who was appointed chancellor of New York University. J. D. Cunningham, past-president and Fellow ASME, chairman of the board of trustees of the Institute, announced Dr. Rettaliata's appointment, who also was appointed president of two other organizations on the campus—Armour Research Foundation and the Institute of Gas Technology.

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MARTIN GOLAND, Mem. ASME, associate director for engineering at Midwest Research Institute, Kansas City, Mo., has been appointed a member of the Committee on Aircraft Construction, a technical affiliate of the National Advisory Committee for Aeronautics. Mr. Goland is editor of the internationally circulated *Applied Mechanics Reviews*, a journal edited at Midwest Research Institute and published by ASME.

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ROBERT PAXTON and C. E. DAVIES, secretary, ASME, have been made life trustees of Rensselaer Polytechnic Institute. Mr. Paxton is an executive vice-president of the General Electric Company. Mr. Davies, Fellow ASME, has been secretary of The American Society of Mechanical Engineers since 1934.

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S. W. ROLPH, president, The Electric Storage Battery Company, was elected president of The Franklin Institute, Jan. 23, 1952, at the annual meeting of the Institute's board of managers.

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J. O. RICE was appointed as administrative vice-president of the American Management Association. He will continue his duties as secretary of the association.

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M. D. MILLER was appointed as full-time secretary and safety code consultant of the Refrigeration Industry Safety Advisory Committee. RISAC is sponsored jointly by representative groups of manufacturers of air-conditioning and refrigeration equipment.

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T. J. KILLIAN has been appointed chief scientist of the Office of Ordnance Research at Duke University. Dr. Killian, who until recently was science director of the Research Division of the Office of Naval Research in Washington, will head a group of scientists in directing and co-ordinating the Army Ordnance Corps' basic research program.

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ALAN HAZELTINE, noted electronics consultant and faculty member at Stevens In-

stitute of Technology for 29 years, was elected president of the Alexander C. Humphreys Foundation. The Foundation was organized a year ago to honor and perpetuate the memory of the late Dr. Humphreys, president ASME (1927), utilities executive and second president of Stevens Institute, who introduced courses which constituted the first approach to management engineering made by any engineering college.

AICE Elects Officers for 1952

AT THE Annual Meeting of the American Institute of Consulting Engineers held on Jan. 14, 1952, and at the meeting of the Council on the next day, the following officers were elected for 1952: C. A. Farwell, *president*, Fay, Spofford and Thorndike, Boston, Mass.; G. S. Richardson, *vice-president*, 901 Park Building, Pittsburgh, Pa.; G. C. Diehl, *treasurer*, New York, N. Y.; C. D. Hanover, Jr., *secretary*, Hardesty and Hanover, New York, N. Y.

1952 ASTM Lecturers Announced

TWO significant lectures are in prospect for the 50th Anniversary Meeting of the American Society for Testing Materials to be held in New York, N. Y., during the week of June 23, 1952.

R. C. McMaster, Battelle Memorial Institute, will deliver the 26th Edgar Marburg Lecture on the subject "Nondestructive Testing." In selecting this subject for the lecture, the ASTM directors were conscious of the ever-growing interest in methods of evaluating materials by nondestructive means. Dr. McMaster is the author of "A Basic Guide for Management's Choice of Nondestructive Tests," an 80-page ASTM technical paper in 1950.

The first H. W. Gillett Memorial Lecture, the establishment of which was recently announced, is to be given by N. L. Mochel, manager, Metallurgical Engineering, Westinghouse Electric Corporation. Mr. Mochel has selected as his subject "Man, Metals, and Power." He is expected to include as a portion of his lecture the background of some of the outstanding work done by Dr. Gillett. In keeping with Dr. Gillett's broad interest—the critical evaluation of metals and alloys—the lecturer will devote a major portion of his address to the use of materials in the field of power generation, including high-temperature and related applications.

The Gillett and Marburg lectures will be presented on Monday and Wednesday afternoons, respectively, June 23 and 25.

Doehler Award Fund Announced

IN April of 1949, Doehler-Jarvis Corporation, a member of the American Die Casting Institute, donated $25,000 for the establishment of a perpetual trust to be known as the Annual Doehler Award Fund. The Institute was appointed trustee of the Fund.

The Award, which is made annually, consists of a suitable plaque and a cash honorarium of at least $500 or more, if the income of the Fund permits and at the discretion of the Award Committee.

The Award Committee consists of the Board of Directors of the American Die Casting Institute, Inc. The Award Committee has sole authority over the selection of the recipient and the operation of the award program.

The Award is to be made annually for the outstanding contribution to the advancement of the die-casting industry, or to the art of die casting as represented by the following: (1) Technical achievement, (2) advancements in plant operations, and (3) other activities, not primarily of a scientific or operational nature that result in the enhancement of the reputation and acceptability of die castings.

Nominations for the Award and supporting papers or other material will be received annually from January 1 to April 30. Entries should be addressed to: Award Committee, American Die Casting Institute, 366 Madison Avenue, New York 17, N. Y.

Manpower-Shortage Transcripts Available

TWO records recently made in co-operation with the Engineering Manpower Commission of Engineers Joint Council, dealing with the manpower shortage, are available to the local delegates.

The most recent, "Manpower Crisis," was primarily made as a transcription and broadcast over stations all over America. It was one of a series of broadcasts under the title "Americans, Speak Up," and was made by T. A. Marshall, Jr., Mem. ASME, executive secretary, EMC, and Bill Slater, noted radio commentator and sportscaster, who acted as interrogator. Several copies of this are available and may be borrowed for group playings by writing EMC headquarters, 29 West 39th Street, New York 18, N. Y.

The second, "Supermen Wanted," was made by Westinghouse Electric Corporation and played during EMC's Pittsburgh Convocation, Sept. 28, 1951. It can be obtained through the Federal Radio Education Committee, Radio Script and Transcription Exchange, Office of Education, Washington 25, D. C., in quantity, or through EMC headquarters where a limited supply is available.

Columbia Engineering Center Plans Endorsed

MANY leading men in industry and in the arts, sciences, and professions have endorsed plans for the new Columbia University Engineering Center.

The Engineering center will be located at Riverside Drive and 125th Street in New York, N. Y. One building on the site already is partly occupied. Completion of the Engineering Center is expected in time for Columbia University's bicentennial anniversary in 1954. A $22,150,000 fund-raising campaign to build, equip, and staff the Center is under way.

Much is said these days of the great need for more engineers, and it is certainly true that at present the demand greatly exceeds the supply, according to O. E. Buckley, chairman of the board of the Bell Telephone Laboratories, Inc. There is, however, a tendency under these circumstances to place relatively too much emphasis on quantity as opposed to quality. Dr. Buckley also pointed out that in the years ahead the greater need will be for more men of education beyond that provided by undergraduate engineering courses, and particularly in the sciences basic to engineering.

The plan for the Engineering Center recognizes this need and the Center should, if properly equipped and staffed, be a great force for our future strength in applied science.

Included among the 67 members of the Columbia University Engineering Center Development Fund's National Committee of Sponsors are: T. A. Morgan, Mem. ASME; G. B. Pegram, Fellow ASME; R. J. S. Pigott, Fellow and president, ASME; G. A. Price, Assoc. ASME; and L. A. Van Bomel, Mem. ASME.

Education

University of Michigan Gives Materials-Engineering Degree

A NEW program leading to a BS degree in Materials Engineering is now available in the college of engineering at the University of Michigan.

The program is designed to permit specialization in the use of a wide variety of materials, including metals.

The first-year program is identical with the schedule taken by all other engineering students. Specialization begins in the second year and becomes more intensive in later portions of the program.

Materials studied include cements, wood, plywood, metals, rubber, plastics, and the like. Emphasis is placed upon the corrosion resistance of these materials and their various protective coatings, such as paints, varnishes, lacquers, and enamels.

The new program is similar in many respects to metallurgical engineering except the materials engineer will take more advanced mathematics, stress analysis, machine shop, machine design, specifications, corrosion and high-temperature properties, and operations of fabrication.

Industrial Photoelasticity Course at M.I.T.

BECAUSE of the increasing need for formal instruction in the photoelastic method of stress analysis, the mechanical-engineering department is again offering a special two-weeks summer course at the Massachusetts

Institute of Technology, Cambridge, Mass., from Aug. 18–Aug. 30, 1952. Included in the program will be a survey of the field of photoelasticity and its applications and discussion of experimental techniques and equipment. The course in photoelasticity, one of four special programs offered by the department of mechanical engineering in summer session 1952 at M.I.T., has been designed primarily for the practicing engineer who has no previous knowledge of the subject.

The course will consist of a series of ten lectures, supplemented by ten laboratory exercises designed to illustrate the material presented in the lectures. Topics to be discussed will include the basic photoelastic theory, auxiliary methods of analysis, photoelastic materials, and laboratory equipment. The program will be under the direction of Prof. W. M. Murray, Mem. ASME, who is in charge of the Laboratory of Experimental Stress Analysis in the mechanical-engineering department.

Letters of application, including appropriate statements to indicate experience and background, should be sent before July 1 to Prof. E. H. Huntress, director of the Summer Session.

Three other special programs will be offered during Summer Session 1952 in the mechanical-engineering field with particular emphasis on manufacturing methods including the design and operation of industrial equipment. The courses are metal cutting, lubrication engineering, and vibration problems. For further information on special Summer Session 1952 activities, address Prof. E. H. Huntress, director of the Summer Session, Room 3–107, Massachusetts Institute of Technology, Cambridge 39, Mass.

Industrial Research Fellowships Announced

THE Armour Research Foundation of Illinois Institute of Technology is offering 15 industrial research fellowships in physics, chemistry, metallurgy, ceramics, engineering mechanics, and electrical engineering to begin in September, 1952.

Those persons awarded fellowships will attend Illinois Institute of Technology half-time and work in the Research Foundation half-time in a graduate program leading to advanced academic degrees. They are employed full-time by the Foundation during the summer.

Further information and application forms may be obtained from the Office of Admissions, Graduate School of Illinois Institute of Technology. Applications received prior to March 15 will be given first consideration.

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THE Missouri School of Mines and Metallurgy offers several opportunities to qualified graduate students for appointment to fellowships or graduate assistantships during 1952–1953. Applications are invited from men holding either a BS degree or an MS degree in special fields. The opportunities are as follows: Research fellowships in mining, metallurgy, ceramics, or geology. Graduate assistantships are offered in mechanical, civil, electrical engineering, and the sciences. Several fellowships and assistantships sponsored by the Federal Government or by various industrial organizations for engineering-science research leading to advanced degrees are available at this time. Application blanks and further information concerning any of these opportunities may be secured from Dr. J. D. Forrester, Missouri School of Mines and Metallurgy, Rolla, Mo.

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THE award of 75 postgraduate fellowships to 47 universities and grants-in-aid to 15 universities to "stock-pile" knowledge through the support of fundamental research, was announced by the du Pont Company, for the 1952–1953 academic year. Of these postgraduate fellowships to be awarded, all of which are predoctoral, 45 are in chemistry, 15 in chemical engineering, five in mechanical engineering, and so on. The fellowships in mechanical engineering were awarded to Columbia University, Lehigh University, Massachusetts Institute of Technology, The Pennsylvania State College, and Purdue University.

Columbia Adds Course in Atomic Physics

A NEW course, especially designed to meet the needs of nonmedical personnel in industry and research who are using various forms of radiation in their everyday work, has been added by Columbia University. The course, in the field of atomic physics, is Radiologic Physics and will be given in the School of General Studies. After a survey of the basic physical facts and theory of radiation, the course treats such topics as radiation measurement, dosage problems in the use of x-ray and radium, protection against radiation, radiobiology, and the use of radioactive isotopes.

The 20 courses in nuclear physics and atomic energy given by Columbia represent a natural outgrowth on the University's continuing interest in the field. The University has maintained a research and study program in many aspects of atomic and nuclear physics. Research in this area has been greatly assisted since the construction and operation in 1950 of the 415 million electron-volt synchrocyclotron at Irvington-on-the-Hudson, N. Y. This tremendously powerful research instrument has been used especially in the study of mesons.

Industrial-Engineering Forum by ASME-UCLA

AN industrial-engineering and management lecture-forum series is being sponsored by the school of business administration, the college of engineering, and university extension, University of California, Los Angeles, Calif., in co-operation with the Industrial-Engineering Division of the Southern California Section, ASME. The purpose of the lecture-forum series is to encourage industrial progress through the sharing and exchange o "know-how" on engineering and management problem-solving techniques. The lecture forums are held twice a month, January through June, and are open to all interested persons at no charge.

Some of the topics are: Production control in modern industry, recent developments in computer design, design of a methods-training program, the learning curve and its industrial applications, case study in participation management, quantitative concepts in the new science of industrial engineering and management, tooling methods for production, and techniques used in the control of quality.

Additional information may be obtained from the office of the Department of Business Administration, University of California, Los Angeles.

Training Industrial Personnel Executives

A CO-OPERATIVE institute for training industrial personnel executives in advanced techniques of employing and advancing workers was held by the University of Houston and Rensselaer Polytechnic Institute at Houston, Texas, on Feb. 25–29, 1952. Those who attended learned how to fit people into the jobs for which they are best suited.

More than 250 industrial personnel executives have attended the seven institutes held at Rensselaer and the laboratory has administered tests to more than 25,000 employees in industry.

Morning and afternoon sessions, on each of the five days were devoted to modern methods for selecting workers and advancing them to the jobs for which scientific tests have shown them best fitted.

Tool Engineers Meeting and Industrial Exposition Announced by ASTE

THE American Society of Tool Engineers has scheduled a comprehensive program for its 20th annual meeting, coincident with the industrial exposition to be held in Chicago, Ill., March 17–21, 1952.

Because of the growing importance of inspection equipment, an entire hall, Precision Control Hall, will be set aside for inspection and quality-control exhibits at the ASTE industrial exposition to be held at the Chicago International Amphitheatre. Opening day of the exposition has been designated as Precision Control Day.

The five-day technical program on precision controls, metal cutting, materials forming, grinding and finishing, and machine accessories, drives, and controls will be highlighted by many papers presented by leaders in these various fields of engineering. The afternoon sessions will be devoted to panel discussions. The technical sessions and panels will be conducted at the Stockyards Inn, Conrad Hilton Hotel (formerly the Stevens Hotel), and Palmer House. Several interesting plant tours are scheduled during the week.

Minerals and Metals Advisory Board Formed

A NEW Minerals and Metals Advisory Board has been organized under the National Academy of Sciences, National Research Council. This Board will serve as a research advisory group to the Department of Defense and to civilian governmental agencies responsible for research and development in mineral technology and metallurgy for the defense effort.

F. C. Frary, recently retired director of research and now technical adviser, Aluminum Company of America, will head the new Board as chairman. Zay Jeffries, retired vice-president, General Electric Company, and R. F. Mehl, director, Metals Research Laboratory, Carnegie Institute of Technology, will serve as vice-chairman of the Board.

The Board has been formed by a reconstitution of the Metallurgical Advisory Board that has been advisory over the past year to the chairman of the Research and Development Board, Department of Defense, on problems of metallurgical research in the Defense Department. The new Board will continue this advisory service to the Research and Development Board and will have the added responsibility of advising civilian defense agencies through the Director of the Bureau of Mines.

The scope of the new Board's interests is expected to cover advisory services in the appraisal of technical problems involved in the production and use of metallic and nonmetallic minerals; the appraisal of problems involved in the treatment of low-grade minerals and ores, and other minerals and ores not commonly processed; technical problems relating to the production of raw materials and intermediates, and the use of substitutes for them, together with new or different processes for production of nonmetallic minerals, and of metals and metal end products, as well as advisory services with respect to the entire field of metallurgical research.

Literature

New and Revised ASTM Standards Announced

YEAR-END action by the Administrative Committee on Standards, American Society for Testing Materials, resulted in a number of new standard specifications and some important revisions.

Nodular-iron castings specifications (339-51T), developed over a period of two years by the Subcommittee on Nodular Iron of Committee A-3 on Cast Iron, aim to satisfy a demand from industry for an acceptable purchase specification for ductile or nodular iron. This iron, also known as spheroidal, is defined as cast iron with the graphite substantially in spherical shape and substantially free of flake graphite.

Revisions in specifications covering sand castings (B80-49T) and sheet (B90-49T) bring the temper designations into agreement with current commercial practice, and in the former a change in the composition of AZ91C accomplishes the same purpose. Approved changes in Specifications for Magnesium-Base Alloy Permanent Mold Castings (B199-49T) add the Temper T6 for Alloy AM100A, and provide for insertion of temper designations to effect conformity with current commercial practice.

A new specification developed by Committee C-16 on Thermal Insulating Materials covers the composition, sizes, dimensions, and physical properties of mineral-wool pipe insulation at elevated temperatures. This is the blanket-type insulation and the designation of the new tentative is C280-51T. A companion specification for molded-type insulation is virtually completed and announcement of its approval is expected after the ASTM March meetings.

Tentative Methods of Testing Drying Oils (D555-51T) have been designed to meet the need of the paint and drying-oil industries for a comprehensive set of methods for the purpose implied. They replace previous ASTM Methods D555-47T, D555-50T, and D967-48T, and include pertinent sections drawn from other related ASTM methods.

The new Method for Measurement of Dry Film Thickness of Nonmagnetic Coatings of Paint, Varnish, Lacquer, and Related Products Applied on a Magnetic Base (D1186-51T) (Magnetic Gage Method) supplements the Tentative Method of Test for Measurement of Dry Film Thickness of Paint, Varnish, Lacquer, and Related Products (1005-49T). It is also recommended for thin films, less than 0.5 mil (0.0005 in.) in thickness. It does not apply to excessively soft films.

Tentative Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal (D1187-51T) is largely a performance-type specification, but does include some general requirements on composition of the material. This material has been in general use for about 20 years and there has been a need for specifications. Methods of tests for these materials were completed in 1949 and were issued under the designation D1010-49T.

Recent revision of Method of Testing Varnished Cloths and Varnished Cloth Tapes Used in Electrical Insulation (295-51T) clarifies certain references to Methods of Test for Electrical Resistance of Insulating Materials (257-49T), the latter method previously having been used for testing varnished cloths and tapes.

Copies of these standards can be procured from ASTM Headquarters, 1916 Race Street, Philadelphia 3, Pa., at a nominal charge—usually 25 cents each.

NBS Publications

THE National Bureau of Standards, U. S. Department of Commerce, published recently the "Bibliography of Books and Published Reports on Gas Turbines, Jet Propulsion, and Rocket Power," by E. F. Fiock and Carl Halpern, of the NBS combustion staff. NBS Circular 509, superseding Circular 482, was published as a result of the rapid progress in the fields of gas turbines and jet propulsion and the greatly increased literature covering the subject; also in answer to the demand for coordination and exchange of relevant scientific knowledge. The price of the bibliography is 20 cents and can be ordered from the Government Printing Office, Washington 25, D. C.

Another new NBS publication is "Hydraulic Research in the United States, 1951," edited by H. K. Middleton and S. W. Matchett, NBS Miscellaneous Publication 201, which provides a guide to the current and completed projects conducted by various hydraulic and hydrologic laboratories in the United States and Canada. The editors have compiled this volume from reports by hydrologic laboratories and it is priced at $1.25 a copy (order from Government Printing Office, Washington 25, D. C.).

"Bibliography on the Measurement of Gas Temperature," by P. D. Freeze, NBS Circular 513, was prepared in connection with a broad program now under way at the Bureau, which includes the development of more accurate and more rugged temperature-measuring instruments, the perfection of various spectroscopic methods, the extension of the theoretical background, and a study of the real significance of the measured values of such temperatures. Accuracy in measurement and control of such temperatures as those of the working media of gas turbines and jet engines presents many problems. The 14-page bibliography facilitates reference to the literature in this field and can be ordered from the Government Printing Office, Washington 25, D. C., priced at 15 cents a copy.

Industrial Management

THE Proceedings of the 15th Annual Time and Motion Study and Management Clinic sponsored by the Industrial Management Society, Oct. 31–Nov. 2, 1951, are available. It is a 128-page book with charts, forms, and illustrations; complete with transcripts of talks by leaders of labor, management, and government on various topics including time study, motion economy, methods, plant layout, materials handling, wage incentives, maintenance, and human relations. Copies may be purchased from the Industrial Management Society, 35 E. Wacker Drive, Chicago 1, Ill., for $4.

Graphical Symbols

AN American Standard, Graphical Symbols for Single (One) Line Electrical-Engineering Diagrams, Y32.1.1—1951, cosponsored by the American Institute of Electrical Engineers and The American Society of Mechanical Engineers, was recently published by the AIEE. The standard, a 42-page book, has 81 graphical symbols, sample diagrams, and is indexed. It may be purchased from the American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N. Y., at $1.40 a copy.

Solder-Joint Fittings

AN American Standard, Wrought-Copper and Wrought Bronze Solder-Joint Fittings, B16.22—1951, was recently published

by The American Society of Mechanical Engineers.

Covered in this standard are the following: Pressure ratings; abbreviations for end connections; size, and method of designating openings of reducing fittings; marking, minimum requirements for material, dimensions and tolerances, and tests.

The 7-page standard may be purchased from ASME Order Department, 29 West 39th Street, New York 18, N. Y., at 75 cents a copy.

Scientific Manpower Shortage

WAYS to overcome the present acute shortage of scientific manpower are suggested in a series of studies, prepared for the Navy, on how to improve the selection, training, and utilization of engineers and scientists. These studies are available to the public.

Each month reports on scientific and technical research done by the Federal Government or with the Government's financial support, which are cleared of secrecy restrictions, are officially released to the public through the *Bibliography of Technical Reports*, a publication of the Office of Technical Services. The yearly subscription rate is $5 and may be purchased from the Office of Technical Services of the U. S. Department of Commerce, Washington 25, D. C., or through the U. S. Department of Commerce field offices.

Orders should be accompanied by check or money order payable to the Treasurer of the United States.

Screw-Thread Standards

THE 1950 Supplement to Handbook H28 (1944), Screw-Thread Standards for Federal Services, replaces and augments the Supplement issued June 15, 1949. It includes the Unified Standards for thread form, for the coarse-thread series in sizes from 1/4 in. to 4 in., inclusive, and for the fine-thread series in sizes from 1/4 in. to 1 1/2 in., inclusive, as agreed upon at the time the Declaration of Accord was signed, on November 18, 1948. It also includes subsequently agreed upon Unified special threads and American National diameter-pitch combinations that have not been recognized as Unified standards, but for which allowances and tolerances have been formulated in accordance with the principles of Unified threads. Tables of tolerances, allowances, and other thread data for threads of special diameters, pitches, and lengths of engagement are also included.

This handbook is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., and costs 50 cents a copy.

* * *

A CHANGE in the Unified 1/8-in. coarse thread from 1/8-12 to 1/8-13 has been recorded in the third printing of the American Standard, Unified, and American Screw Threads (for Screws, Bolts, Nuts, and Other Threaded Parts) issued recently. Publication of the third printing, made necessary by the fact that copies of the second printing are no longer available, presented an opportunity to record the change in the Unified coarse thread as well as to correct typographical errors. An Agreement reached between the United States, the United Kingdom, and Canada in regard to five threads in nominal sizes below 1/4 in. as Unified threads, was too late to be mentioned in this printing—therefore a loose sheet addendum containing this information is enclosed in each copy of the new issue.

The change in the 1/8-in. thread was decided upon recently as a result of agreement between British and American groups.

Copies of the third printing of the American Standard on Unified and American Screw Threads for Screws, Bolts, Nuts, and Other Threaded Parts, B1.1—1949, may be obtained from the American Standards Association, 70 East 45th Street, New York 17, N. Y., at $3 a copy.

Employee Inventory

A NEW questionnaire designed to help companies find out what their employees honestly think about their jobs, their pay, their bosses, and the company they work for, is available from Science Research Associates of Chicago.

Called the Employee Inventory, it is simple to give, inexpensive, and reliable. Employees' answers are completely anonymous, but the questionnaire allows management to measure morale for the company as a whole; to compare morale between different departments, or plants; and to compare morale in any given company with the average for others, particularly in their own industry.

In use, the questionnaire lets employees tell how they feel about working conditions, management, job security, benefits, pay, supervision, other employees, advancement—and indicates the effectiveness of company communication and employee relations activities.

Companies using this industrial relations tool have found it of help in discovering training needs, pin-pointing weak departments, cutting down employee turnover, and building community good will.

Industrial-relations authorities responsible for this aid are the Employee Attitude Research Group of the Industrial Relations Center of The University of Chicago. The questionnaire is the outgrowth of studies of employee attitudes at Sears Roebuck, Campbell Soup, Johnson & Johnson, New York Central Railroad, Spiegel, Visking, the Weyerhaeuser Timber Company, and many other business concerns. For details and prices, write Science Research Associates, 57 West Grand Avenue, Chicago, Ill.

Steel Products Manual

SECTION 22 of the Steel Products Manual covering Forged Axles and Locomotive Forgings is the fifth revised edition of the pamphlet which was originally published in February, 1939. The purpose of the Steel Products Manual is to make available to purchasers, producers, consumers, and all others interested, information covering the major steel products. Each of the 30 sections, which comprise the manual, deal with tolerances, methods of inspection, sampling and chemical analysis, definitions of technological terms, and other related subjects, which have developed in the manufacture and use of iron and steel.

Copies of the pamphlet can be purchased from the American Iron and Steel Institute, 350 Fifth Avenue, New York 1, N. Y., for 25 cents each, postpaid.

EMC Pittsburgh Convocation

THE Engineering Manpower Commission Pittsburgh Convocation brochures, containing all the material covering the Convocation which was held at the University of Pittsburgh, Sept. 28, 1951, are available. Included in the reprint are the afternoon question-and-answer session and Newsletters, 1 to 9, inclusive. Copies may be obtained from EMC Headquarters, 29 West 39th Street, New York 18, N. Y., at $1 a copy.

Junior Forum

What Have You Accomplished Professionally?

By Joseph Schmerler[1]

THE difficulty of finding an adequate position does not exist for the young engineer today. There is a shortage of junior engineers and the competition for the current supply is keen. Graduating classes of engineers are subjected to intensive recruiting campaigns by both government and industry. This is a sellers' market.

Once out in industry the young engineer can concentrate on a program of personal improvement with ease of mind. There is no underlying fear of extended unemployment. This assurance of employment should channel the personal activities of the junior engineer into the avenue of professional development.

Broadly speaking, the meaning of the term professional development is common good citizenship with technical and social improve-

[1] Design Engineer, Celanese Corporation of America, New York, N. Y. Jun. ASME.

ment thrown in. Good citizenship includes an awareness of domestic and foreign affairs and activity in local community life. Technical improvement is obviously the acquisition of additional skill in engineering, and social improvement involves proper association with people during both business and leisure hours.

In the January and February, 1952, issues of MECHANICAL ENGINEERING the Junior Forum carried reports pertaining to the responsibility of industry in training the engineer and the responsibility of the engineer toward his job. The remaining topic is the responsibility of the engineer toward himself. This is the chapter which includes professional development.

To aid the engineer in assaying the extent to which he has progressed in his professional development, the National Junior Committee of ASME recently published the following score card which is adapted from an address given by C. M. Stanley, Mem. ASME, partner, Stanley Engineering Company, Muscatine, Iowa, at the Junior Conference, ASME Semi-Annual Meeting, June, 1950:

How Is Your Professional Development?

Are You on the Right Track?

Are You Doing the Things You Ought to Be Doing?

Here is an easy way to find the answers:

Read the following nine groups of questions. If, to each of the first groups, you can answer "Yes," give yourself *two* points. For the ninth group, if your answer is also "Yes," give yourself *four* points.

Now! Study the questions and rate yourself:

1 Are you absorbing more and more technical information about your own particular job? Do you read the latest articles and papers about the engineering techniques involved in your work? In other words, are you becoming a master of your specialty?

2 Do you like the company with which you are associated? Are you familiarizing yourself with its organization, its methods, policies and procedures, its prospects, and its problems? Do you know why your company does the things it does the way it does them?

3 Are you broadening your engineering knowledge by learning more about how your specialty is related to other fields of engineering? Are you keeping abreast of engineering developments, new materials, new methods, new procedures?

4 Do you act and feel like a professional man? Are you acquainted with the "professional" problems of engineering? Are you familiar with EJC and ECPD?

5 Are you a registered professional engineer? If not, have you familiarized yourself with the laws for registration in your state? Are you taking steps toward meeting these requirements?

6 What are you doing to improve your communication skills? Are you taking any courses in report writing or reading good literature that will help you to become wordwise? How about public speaking? Do you stand up and speak your piece before technical, social, and church groups?

7 How aware are you of the importance of working with people? Have you studied the fundamentals of human relations? Are you trying to better yourself in the art of getting along with others?

8 Are you aware of the currents and eddies of economic, political, and social thinking? Do you know how they affect you, your community, your country, and your world? Have you taken steps to make yourself better informed on the basic problems of society?

9 In the events around you, would you consider yourself a participant or an observer? Do you exercise all the rights and duties of citizenship? Are you actively engaged in projects of your community, your church, and your professional society? Are you really aware of the importance of citizenship to the extent that you are doing something about it?

Young Man! If you have scored below 16, get yourself into a corner and scrutinize your soul! Do you or do you not want to be an engineer?

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th Street	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

Men Available[1]

Mechanical Engineer, 39, married, PE New York. Experience includes testing, inspection, maintenance, and administrative duties. Desires position as assistant to chief engineer or plant manager. New York State preferred. Me-868.

Mechanical Engineer, development, design of automatic devices involving analysis of stress, motion, vibration, controls; six years' experience. Pursuing Master's, author of technical papers, knowledge shop practices. Desires stable New York firm. Me-869.

Positions Available

Sales Engineer, recent graduate, to train for sales career with national manufacturer of conveyers, pneumatic dispatch tubes, and industrial blowers. Training will include factory program in upstate New York, and layout drafting and estimating on sales proposals for a period of one or two years in Maryland. Y-6142.

Sales Engineers, mechanical and electrical, for field and factory sales-engineering positions for nationally known manufacturer of leading product selling to original equipment-machinery builders. District managerships available. Salary open, plus incentive plan. Wis. Y-6410.

Plant Manager, graduate mechanical engineer, for a chemical-manufacturing division. Must be thoroughly familiar with process-type production. $20,000–25,000. Ill. Y-6434.

Engineers. (*a*) Chief engineer, over 40, mechanical or metallurgical graduate, administrative, design, construction, and plant-engineering experience in metallurgical-furnace field and mill construction. $15,000. (*b*) Assistant project engineer, mechanical or civil engineering graduate, at least ten years' process-plant construction experience, to supervise field co-ordination covering mill construction. $10,000. Western N. Y. State. Y-6446.

Production Manager, under 50, to assist works manager and take charge of industrial engineering including time study, wage standards, production methods, tool engineering, tool design, etc., for electromechanical instrument manufacturer. $15,000. Newark, N. J. area. Y-6483.

Mechanical Engineers, not over 45, BS degree, or the equivalent in practical experience in mechanical engineering. (*a*) Mechanical engineer at least three years' experience in preparation of designs, estimates, and specifications for machinery of various types. $6325. (*b*) Mechanical engineer, a minimum of one year's experience. Must have at least general experience in machine and machinery design. $5256. Free transportation for employee and family and moving expenses. Must be American citizens. Panama. Y-6500.

Chief Engineer for company engaged in precision casting. Should have considerable experience in the die-casting field and be responsible for process and plant engineering. $10,000–$12,000. Ohio. Y-6503.

Mechanical Engineers. (*a*) Senior project engineer, mechanical graduate, for development and administrative work. Should have from five to ten years' experience on mechanical and electromechanical devices. Will direct subordinate engineers in this work. From $5760, depending upon experience. (*b*) Project engineers, mechanical graduates, to work under senior project engineers. Should have had to five years' experience as above. $5088. (*c*) Research trainee, graduate mechanical, good academic standing and an interest in research for research and development on mechanical and electromechanical devices. $3324. Regular increments. (*d*) Machine designer, four years' experience, to work with research group on mechanical and electromechanical devices. $4805. Brooklyn, N. Y. Y-6505.

Junior Mechanical or Civil Engineer, to call on architects, engineers, contractors, and manufacturers regarding rock products and accessories. Some traveling. $3900–$4200. New York, N. Y. Y-6506.

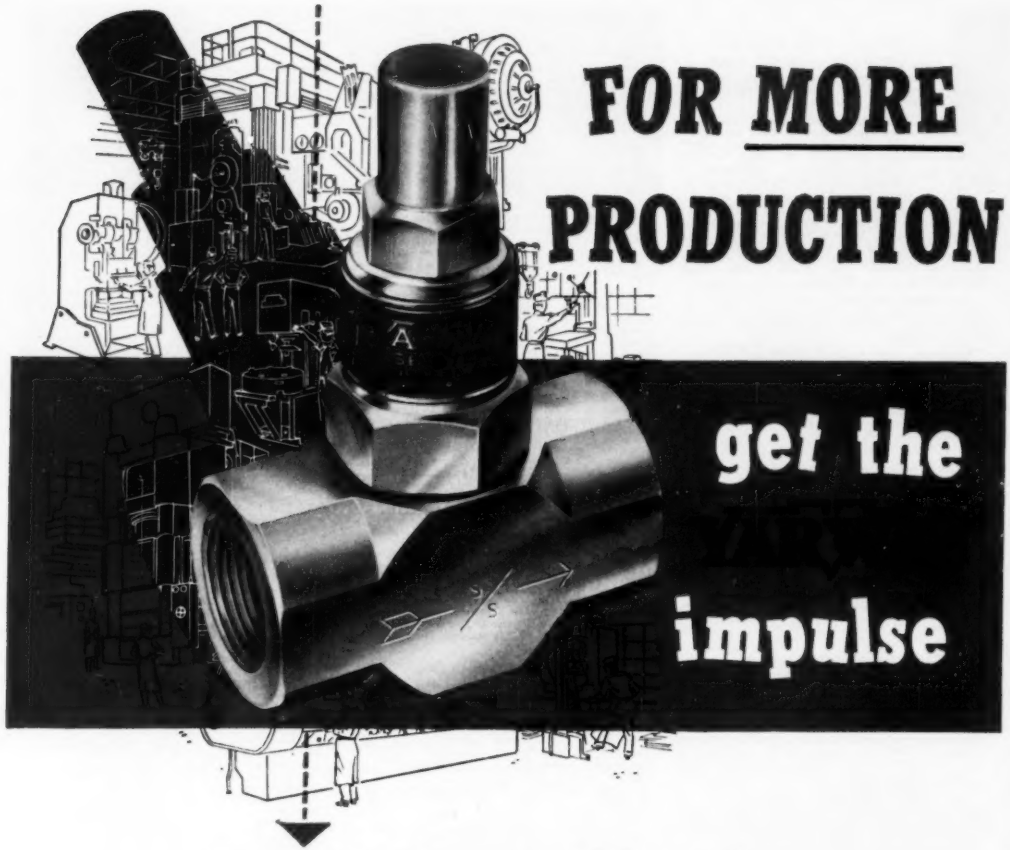
Editor, at least five years' supervisory experience in technical publishing fields covering automotive armaments, controls, etc. $10,000–$12,000. Detroit, Mich. Y-6511.

Methods Engineer, mechanical, up to 50, five or more years' experience in methods work in machine tools and machine shop. Duties will include methods and production work on machine tools, plant layout, and some production tools, jigs, and fixtures. Company will pay fee and moving expenses. $10,000. Upstate N. Y. Y-6512-T-8495.

Vice-President in Charge of Engineering, 40–45, for company manufacturing automotive com-

(*ASME News continued on page 270*)

[1]All men listed hold some form of ASME membership.



Want more production from your steam-heated equipment? Yarway Impulse Steam Traps may be your answer! Here's why. Yarway Impulse Traps provide constant and complete condensate drainage, **plus** air and gas removal, **plus** velocity scrubbing of heat-retarding condensate from the heat transfer surfaces. In plant after plant, **equipment drained with Yarways gets hotter, sooner . . . and stays hot!**

The exclusive Yarway "impulse" design has other advantages. For example—small size, one moving part, straight line piping, good for all pressures, low cost and low maintenance.

Nearly 750,000 Yarways have already been installed in thousands of plants in nearly every industry. Get Yarways from your nearby industrial distributor . . . 216 stock and sell Yarways.

FREE TRAP BOOK

It's full of valuable steam trap data. Write for your free copy of this new 24-page book today.

the steam trap designed with more production in mind

YARNALL-WARING COMPANY● 108 MERMAID AVENUE, PHILADELPHIA 18, PA.

ponent parts in five different plants. Will be in charge of product engineering, product development, and general co-ordination of all engineering. $25,000. Midwest. Y-6523.

Planning Engineer, 30–40, several years' experience in the co-ordination of sales with production. Should have had one or two years' manufacturing experience in textiles. Position with consulting-engineering firm. Traveling required. $8000–$10,000. New York, N. Y. Y-6544.

Mechanical or Electrical Engineer, to 60, factory shop experience, to become superintendent of small plant. Must have had some experience in production, preferably small parts, and be familiar with assembly, soldering, machine operations, etc. Must have successful record of handling employees. $8000, plus bonus. New York Metropolitan area. Y-6554.

Mechanical Engineer, eight to ten years' experience in the design and installation of large coal-handling systems. $12,000. New York, N. Y. Y-6571.

Engineers. (*a*) Assistant chief or chief engineer, for research and development. Mechanical graduate preferred, electrical background for company manufacturing railroad car electrical equipment and mechanical equipment. Headquarters, New York State. $8000–$10,000. (*b*) Sales engineer, 30–35, some experience with railroad or railway-car equipment. Some traveling. $5400. New York State. Y-6580.

Superintendent of Plant and Chief Engineer, preferably mechanical graduate, some design experience and ability to organize a manufacturing plant making chrome-plated furniture, metal window frames, etc. $12,000–$15,000. Colombia, S. A. Y-6583.

Sales Engineer, mechanical or chemical graduate, under 30, process-industry sales experience, to contact industrial concerns for sale of high-temperature liquids for process work, discuss engineering problems, make preliminary layouts of plants, and assist in working up contracts. Will serve as staff member of small organization. Traveling in industrial Northeast. $6000–$8000. New York, N. Y. Y-6610.

Assistant Chief Mechanical Engineer, at least ten years' design, layout, and development experience on electromechanical devices for aircraft-instrument work. $8000. Northern N. J. Y-6611.

Research Safety Engineer, 25–35, mechanical-engineering background, ability to write technical reports in the field of crash-injury research relative to private automobiles. Traveling about 30 per cent of time. $5500–$6000, plus $12 a day expenses. New York, N. Y. Y-6615.

Production Manager, 35–45, experience on direct line production for metal forming, plant layout, scheduling, and costs. $10,000–$12,000. Southern N. J. Y-6618.

Production Designer, mechanical, some experience in design work of precision mechanisms, such as cameras, calculating machines, business machines, etc., and having a mechanical-engineering degree. Work consists of the design of production items, specialized features, and component or detail sheet metal parts. Supervision and directing of personnel assigned to detailed design work. Salary open. Ohio. Y-6624.

Technical Writer, mechanical graduate, several years' experience in technical writing for trade journals, such as *Power, Heating and Ventilating Engineering*, etc. $5000–$7500. New York, N. Y. Y-6634.

Industrial Engineer, 28–35, some experience in motion and time study, work simplification, and, in general, to get out production on steel forgings, machine shop, stamping mill, smelter, and copper-reclamation plant. $6000–$7200, plus cost-reduction bonus. Northern Mich. Y-6636.

Engineers. (*a*) Division superintendent, to supervise the installation and maintenance of heavy mechanical equipment, such as distillation units, high-pressure boiler and generator plants. Will take charge of entire mechanical equipment. $26,000, 70-hour week. Temporary, six to eight months. (*b*) Assistant division superintendent, for work similar to above. $23,400, 70-hour week. Superintendents, $18,000–$20,000, 70-hour week. Arctic region. Y-6637.

Industrial Engineer, 35–40, at least eight years' experience covering methods, planning, costs, materials handling, warehousing in commercial fields, to supervise merchandising methods, cost and budget preparation, and plan general improvements. $8000–$10,000. Ga. Y-6638.

Chief Mechanical Production Engineer, graduate, 35–45, ten years' experience in mechanical engineering, production experience from an engineering standpoint. Knowledge of electronics, miniature instruments, production, tooling. Will direct all mechanical and production engineering, collaborate with electronic-engineering department in matters of original design and development of new products, including Government controls, for a manufacturer of electronic instruments. $9000–$12,000. Occasional traveling. Mass. T-8564(*a*).

Factory Superintendent, mechanical graduate, over 35, ten years' experience supervising machinery fabrication and assembly and manufacture of medium-size industrial equipment. Will take charge of production, supervising foremen, and about 100 employees. Will report to general manager. Company manufactures fire extinguishers. $7200, and up. Housing available. Company will pay fee and moving expenses. Wis. T-8570.

Plant Superintendent, 40–45, mechanical or industrial, over five years' experience supervising manufacturing in machine shop and assembly operations. Knowledge of machine-shop and assembly operations. Will supervise production for manufacturer of pumps, elevators, and refrigerations. Train for works manager—responsibility later. Company may negotiate fee. $12,000. Ill. T-8593.

Agricultural Equipment-Design Engineer, mechanical, 30–40, four years' experience in designing farm machinery, potato, sugar-beet harvesters. Knowledge of general agricultural and engineering design. Will design, test, and prepare for production specialty farm-machinery units for a manufacturer. Salary open. Travel in connection with experimental work. No car required. Idaho. T-8611.

Theoretical, Applied-Mechanics, Research Engineer, PhD, up to 45, strong on stress analysis and able to pass rigid physical examination. High-level research work in applied mechanics for a refinery. Up to $12,000. Ill. R-8530(*a*).

Mechanical Designer, mechanical graduate, five years' experience designing power plants, conveyer systems, and/or piping and ducts, pipes and conveying systems for engineering architectural firm. Company will pay fee. Up to $6760. Ill. R-8537.

Design-Development Engineer, mechanical, several years' experience in design-development manufacturing. Experience on heavy equipment, mining equipment preferred. Knowledge of mechanisms, electrical control, and machinery applications desirable. Will be required to make field investigations; do some board work, and engage in engineering-department activities for a manufacturer of mining equipment. Should have design ability, commercial slant, and potentialities for developing administrative ability. Company will pay fee. $6000–$7200. Ill. R-8591.

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after March 25, 1952, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

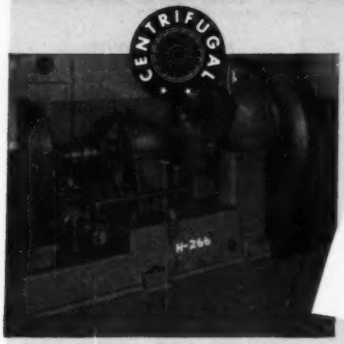
NEW APPLICATIONS

For Member, Associate, or Junior

AMBERG, STEPHEN W., Chicago, Ill.
ANDERSON, ROBERT, Baltimore, Md.
ARNER, GEORGE R., Philadelphia, Pa.
BACCICH, GEORGE M., New Orleans, La.
BAMBERGER, GLENN R., Marshalltown, Iowa
BATES, JAMES L., Beaumont, Texas
BEALS, PAUL D., North Canton, Ohio
BERCHER, JOSEF W. J., Downingtown, Pa.
BEZVERKOV, ALEXIS T., Detroit, Mich.
BORAES, HENRY E., Medford, Mass.
BRAND, JOHN R., Wilmington, Del.
CANNADAY, RICHARD L., New York, N. Y.
CAPERTON, WILLIAM F., New Orleans, La.
CARTER, HUGH C., Los Angeles, Calif.
CLIFFORD, ROBERT W., Spartanburg, S. C.
COLE, SIDNEY A., Verona, N. J.
COLOTELO, JOHN, Sarnia, Ont., Can.
COOPERSMITH, BERNARD, Irvington, N. J.
COPIAN, LOUIS P., Worcester, Mass.
CROSBY, CHARLES H., Temple City, Calif.
CROSS, MARK W., Salt Lake City, Utah
DAVEY, GERALD F., Holden, Mass.
DE HOND, HARDON E., Cheshire, Conn.
DI FRANCO, SALVATORE G. D., Napoli, Italy
DORRIS, G. P., Jr., Webster Groves, Mo.
DRAKE, ROBERT A., Alton, Ill.
ENTWISTLE, J. E., Astoria, L. I., N. Y.
FEAR, S. L., Toronto, Ont., Can. (Rt)
FINN, JOHN S., Burlingame, Calif.
FORNEY, ROSE H., Dallas, Texas
FRASER, WARREN H., Elizabeth, N. J.
GHOSE, RAI SAHEB S. C., Hazaribagh, Bihar, India
GILLETTE, EDWARD S., Bridgeport, Conn.
GLEIMER, BERNARD, Flushing, L. I., N. Y.
GLENN, HARWOOD C., Newark, N. J.
GRAUS, HYMAN, Alexandria, Va.
GURLEY, HENRY F., Charlottesville, Va.
HAIGHT, HOWARD N., Alhambra, Calif.
HARTWEIN, C. E., St. Louis, Mo. (Rt)
HASSAN, AMIR, New York, N. Y.
HAVELKA, ANTHONY W., Omaha, Neb.
HERMES, WILLIAM H., San Diego, Calif.
HERR, FRED R., Havertown, Pa.
HOGENDOBLER, HENRY R., Toledo, Ohio
HOLLYER, J. H., Jr., Ridgewood, N. J. (Rt & T)
HOOK, HENRY L., Houston, Texas
HUBER, E. J., Jr., Salt Lake City, Utah
HUHN, THOMAS H., Jamestown, N. Y.
JAMES, HERBERT O., Oak Park, Ill.
JOHNSON, ARTHUR D., San Diego, Calif.
JONES, WILFRED A., Hamilton, Ont., Can.
KALIKOW, SEYMOUR M., Plainfield, N. J.
KERMAN, KENNETH C., Syracuse, N. Y.
KINNE, BIRGE W., Jr., Houston, Texas
KIRSCHNER, GEORGE J., Allendale, N. J.
KORNETZKY, JOHN C., Cuba, N. Y.
LAWRENCE, LOVELL, Jr., Mountain Lakes, N. J.
LEONARD, JOHN N., Bremen, Ind.
LEWIS, FRANK T., Schenectady, N. Y.
LEYENBERGER, JOHN, Willow Grove, Pa.
LIZON, JOHN W., Wellsburg, W. Va.
LOWRY, EMMERT M., Jr., York, Pa.
LYTLE, JESS R., Latrobe, Pa.
MACKAY, JOHN, Camberley, Surrey, England
MALLANDER, RICHARD G., Calgary, Alba., Can.
MANN, ROBERT L., York, Pa.
MARBURGER, T. E., Baltimore, Md.
MARSHALL, C. W., Lansdowne, Pa.
MASSIE, ULUS W., Jr., Huntsville, Ala.
MATLIN, JACK E., Point Mugu, Calif.
MCCREERY, JAMES F., Latrobe, Pa.
MCGOVERN, THOMAS J., Oak Park, Ill.
MCKITTRICK, LEE, Seattle, Wash.
MCMEANS, W. L., Laughlintown, Pa.
MELANSON, A. C., Montreal, Que., Can.
MELDRUM, P. K., Camp Lejeune, N. C.
MOORE, FRANCIS L., Erie, Pa.
MOUNTFORD, G. S., Cleveland, Ohio
NEWELL, WILLIAM A., New York, N. Y.
NIBLEY, PRESTON P., New York, N. Y.
NILES, DONALD E., West Allis, Wis.
NOCK, EDMUND K., Danvers, Mass.
ORDONEZ, CARLOS R., Lackawanna, N. Y.
ORSINO, ANTHONY J., Troy, N. Y.
OSTRANDER, IRVEN R., Yeadon, Pa.
PAYNE, DALE J., Naperville, Ill.
PEARSON, ROBERT T., Irvington, N. J.
PEEKE, R. C., Fairfax, Wilmington, Del.
PREMISTER, W. I., Brampton, Ont., Can.
PHILBROOK, W. M., San Gabriel, Calif.
PRATER, NILON H., Beaumont, Texas
RANDALL, BRUCE O., Johnson City, N. Y.
REVILL, A. H., Montreal, P. Q., Can.
SAITO, SHOZO, Tokyo, Japan (Rt)
SAXMAN, DUANE S., Latrobe, Pa.
SCHAFFER, IRVING, Alexandria, Va.
SCHMIDT, RALPH G., Chicago, Ill.
SCHMIDT, RICHARD C., Amite, La.
SELLICK, JAY P., Nashville, Tenn.
SHALLENBERGER, F. K., Stanford, Calif.
SKEAD, E. K., Hawkesbury, Ont., Can.
SKOLNIKOFF, BENJAMIN, Jackson Heights, L. I., N. Y. (Rt & T)
SMITH, MERL, Trenton, N. J.
SNELSON, RODGER K., Decatur, Ill.
SPEAR, R. D., San Mateo, Calif. (Rt & T)
STAMP, J. H., New Brunswick, N. J. (Rt & T)
SUITER, WAYNE D., Alexandria, Va.
SUKUMAR, DUTT, York, Pa.
SWANSON, O. F., Jamestown, N. Y.
TEMPLE, G. E. M., Farnham, Surrey, England
THAYER, GORDON B., Midland, Mich.
THOMAS, TUDOR S., Pittsburgh, Pa.
THOMPSON, MORRIS, Baltimore, Md.
TUTTON, ROSS W., Buffalo, N. Y.
WILLIAMS, CHARLES D., Raleigh, N. C.
WIMMER, HERMAN J., Lakewood, Ohio
WOOD, JOHN T., Bridgeport, Conn.
YIN, CHO-LAN, Hong Kong, China (Rt & T)
ZAVELS, MOSE, Knoxville, Tenn.

(*ASME News continued on page 272*)

BETTER SAFE THAN SORRY WHEN YOU'RE MOVING GAS OR AIR



Type OIB Single-Stage Centrifugal Blower in automobile plant. Capacity 13,850 cfm.

- ☐ Choice of Rotary or Centrifugal
- ☐ Capacity matched to the job
- ☐ Easy accessibility
- ☐ Ruggedness
- ☐ Ease of installation
- ☐ Ability to handle overloads
- ☐ Long-time durability
- ☐ Freedom from breakdowns
- ☐ Low maintenance costs
- ☐ Engineering assistance
- ☐ Proved reputation of maker
- ☐ Customer satisfaction

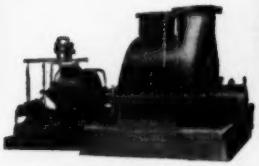
You can't afford to take chances when production and profits depend on maintained performance of blowers, exhausters, gas pumps or related equipment. So, we suggest that you check carefully the above factors before you make your final decision.

If you are faced with a choice between Centrifugals or Rotary Positives, remember that only Roots-Connersville makes both types. From our exclusive *dual-ability line*, with capacities from 10 cfm to 100,000 cfm, at moderate pressures, most buyers can find a unit closely matched to their specific needs.

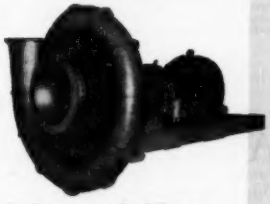
We'd like to remind you, too, that for almost a century we've built only blowers and related equipment. Our products have a long, happy record for outstanding, reliable, economical performance. Our vast reservoir of engineering experience is always at your service, to meet almost every industrial problem of moving gas or air.

ROOTS-CONNERSVILLE BLOWER CORPORATION
522 Michigan Avenue, Connersville, Indiana

THE *DUAL-ABILITY* LINE OF MODERN EQUIPMENT TO HANDLE GAS AND AIR

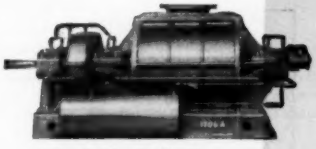


Multi-Stage Centrifugal Exhausters



Single-Stage Centrifugal Blowers

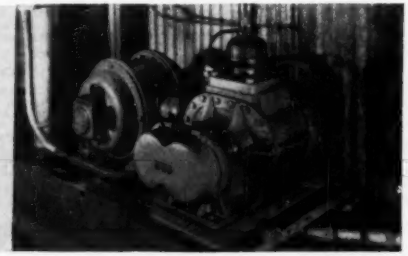
Rotary Positive Blowers



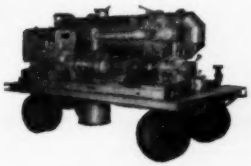
Rotary Positive Gas Pumps

ROTARY

Type RF-2 Rotary Positive Vacuum Pump in chemical plant. This unit replaced a 25-year-old R-C pump, partially destroyed by fire, which has been repaired for other service.



Positive Displacement Meters



Inert Gas Generators

Reg. U.S. Pat. Office

ROOTS-CONNERSVILLE

BLOWER BUILDERS SINCE 1854

ONE OF THE DRESSER INDUSTRIES

CHANGE IN GRADING

Transfers to Member and Associate

ALPERT, SUMNER, San Diego, Calif.
ANDERSON, J. S., Provo, Utah
BISCHOFF, CLIFTON A., New Brunswick, N. J.
BUTT, WAYNE C., San Diego, Calif.
CRAIG, WILLIAM H., Nitro, Que., Can.
CRANE, ALBERT, Los Angeles, Calif.
FINCH, ALBERT M., Lancaster, Pa.
GIBBS, ROBERT G., Honolulu, T. H.
HARROD, CHARLES F., Jamestown, N. Y.
HERTZ, DAVID B., New York, N. Y.
HOQUE, JACK E., Dhahran, Saudi Arabia
JONES, JOHN F., New Orleans, La.
KELLY, JOHN J., JR., Evanston, Ill.
KOSTTING, JOHN L., San Diego, Calif.
MCSWEENEY, JEREMIAH, San Diego, Calif.
NELSON, FRANCIS P., Brooklyn, N. Y.
OLSEN, R. A., W. Lafayette, Ind.
OLSON, REUBEN M., Minneapolis, Minn.
PETERSON, HENRY F., Rockford, Ill.
RUNQUIST, ERNEST M., San Diego, Calif.
SACKS, NEWTON N., Rock Island, Ill.
SCHROEPFER, JOHN T., San Diego, Calif.
STOVALL, BENJAMIN L., San Diego, Calif.

Transfers from Student Member to Junior 90

Obituaries

Louis Blake Bonnett (1867–1951)

LOUIS B. BONNETT, retired mechanical engineer, died Dec. 11, 1951, in Alexian Brothers Hospital, Elizabeth, N. J. Born, New York, N. Y., June 8, 1867. Parents, Daniel B. and Margaret Augusta Bonnett. Education, ME, Stevens Institute of Technology, 1889. Married Elizabeth W. Kiggin, 1903. Mem. ASME, 1911.

Maurice Alton Butterfield (1882–1951)

MAURICE A. BUTTERFIELD, submaster and department head, Lowell Trade School, Lowell, Mass., died May 6, 1951. Born, Wilton, Me., June 15, 1882. Parents, Frank A. and Jessie M. Butterfield. Education, 3 years, Lowell High School. Married Gertrude Sewell Allen (died 1948). Mem. ASME, 1948.

James Craig (1865–1951)

JAMES CRAIG, skipper of the winning power yacht in the first New York-to-Bermuda race, and marine engine manufacturer in New York, N. Y., for 35 years before his retirement in 1926, died Dec. 9, 1951, in his home at Cowesett, R. I. Born, Glasgow, Scotland, June 21, 1865. Parents, James and Jessie Craig. Education, ordinary home schools. Naturalized U. S. citizen. Married Emma C. Groff, 1898. Mem. ASME, 1897. He was manager of the New York Motorboat Show for 30 years and was donor of the James Craig Trophy, now a prize for ocean powerboat racing in West Coast waters. Survived by wife; a son, Donald; two daughters, Mrs. Tracy L. Bryant and Mrs. Frederick Van Benschoten; and five grandchildren.

Edward Stratton Jones (1886–1951)

EDWARD S. JONES, retired consulting engineer, died in Los Angeles, Calif., Nov. 13, 1951. Born, Boston, Mass., April 27, 1886. Parents, Edward C. and Mary (Stratton) Jones. Education, technical high school, California School of Mechanical Arts. Married Allene Brooks, 1910 (deceased). Mem. ASME, 1919.

Lewis Jones (1869–1951)

LEWIS JONES, president, Lewis Jones Co., manufacturer of industrial safety devices, Youngstown, Ohio, died Oct. 12, 1951. Born, Granville, Ohio, March 13, 1869. Parents, Benjamin and Margaret Jones. Education, high school; private instruction. Married Ella M. Jones, 1900 (died 1925). Mem. ASME, 1915. Survived by son, James R., Youngstown.

Erik Gustav Landberg (1899–1951)

ERIK G. LANDBERG, assistant chief engineer, Gould Pumps, Inc., Seneca Falls, N. Y., died July 15, 1951. Born, Ostersund, Sweden, May 25, 1899. Parents, Gustaf Emil and Matilda (Eriksson) Landberg. Education, ME, Technical College, Stockholm, 1920. Naturalized U. S. citizen. Married Darthea E. Wilgus, 1926. Mem. ASME, 1947. He received a U. S. Navy citation for his work in the development of centrifugal pumps for submarines, 1947. Survived by wife and three children, Marion E., Erik W., and George G.

Sidney Paul Schafer (1895–1951)

SIDNEY P. SCHAFER, salesman, Dayton and Bakewell Machine Tools, died Dec. 26, 1951, in Long Beach, Calif. Born, Brooklyn, N. Y., Jan. 5, 1895. Parents, George W. and Ella (Dean) Schafer. Education, graduate, Commercial High School. Married, Grace Gould Rice (died 1949). Married 2nd, Hazel Warren Rice, 1950. Jun. ASME, 1924; Assoc.-Mem. ASME, 1925; Mem. ASME, 1935. Survived by wife and two stepchildren, Martha E. Glenn and John S. Lawliss.

Charles Ewing Smith (1924–1951)

CHARLES E. SMITH, engineer, Power and Fuel Division, Geneva Steel Co., Provo, Utah, was killed in a highway accident near Evanston, Wyo., Dec. 2, 1951. Born, Denver, Colo., Nov. 6, 1924. Parents, Charles W. and Lulu (Galloway) Smith. Education, BSME, University of Colorado, 1949. Married Mildred Grigs, 1947. Jun. ASME, 1949. Survived by wife and son, Gregory L., his parents, two sisters, and a brother.

Ralph Emerson Turner (1879–1951)

RALPH E. TURNER, former editor, *Power Engineering*, died Nov. 28, 1951, at his home in Western Springs, Ill. Born, Columbus, Neb., March 9, 1879. Parents, Moses K. and Eliza Jane (Craig) Turner. Education, BSEE, University of Nebraska, 1906. Married Hulda Victoria Malm, 1911. Assoc-Mem. ASME, 1915; Mem. ASME, 1924. He served the Society on many committees and as chairman, Chicago Section, 1938–1939. Survived by wife and four sons, Ralph E., Jr., Allen C., John M., and Donald P.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult reverse side of card for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting your address, business connection, and Professional Divisions enrollment is printed on this page. Please use it to keep the master file up to date.

Four weeks are required to complete master-file changes.

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Address of employer ..... (Street, City, Zone, State) ☐

Product or service of company .....

Title of position held .....

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1 .....

2 .....

3 .....

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offers an amazing new kind of dependability and operating economy!

Don't be satisfied with *less* than the *best* when you select air conditioning equipment! Choose Servel and get proven dependability . . . dependability that is backed by a *written warranty five times as long* as any comparable sized unit!

Get exclusive flexibility of operation that lets you choose the *most economical power source* for *your* locality, *your* installation! Get the smooth, vibrationless "no moving parts" operation of Servel's famous absorption cooling unit . . . the unit that delivers peak performance year after year with an absolute minimum of maintenance!

Get *more* for your money *every* way with the *quality* line of air conditioning equipment—Servel!

SERVEL alone, gives you these 4 major advantages!

1 Servel uses present steam sources!

Connect Servel units to your present steam source . . . use gas, oil, LP gas, waste heat or steam at any pressure. With Servel *you* pick the most economical energy source, keep operating costs low!

2 "No moving parts" design cuts maintenance!

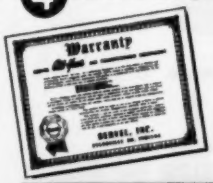
Because there is nothing in the Servel absorption principle refrigerating unit to wear out . . . you get silent, continuous operation, top performance with a bare minimum of maintenance.

3 Custom fitted to do your job best!

Want to air condition a store, office or factory? Need chilled water for processing? Want cooling only . . . or year 'round air conditioning? Servel has the unit or combination to do it best.

SELECT SERVEL . . . the air conditioning that offers low operating cost, guaranteed dependability in residential, commercial or industrial installations.

4 Servels are guaranteed five times as long!



Each Servel refrigeration unit is warranteed for five full years! That is five times as long as all other comparable units. What greater guarantee of long life and dependability can you get?

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Servel, Inc., Dept. ME-3, Evansville 20, Indiana

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Made by the makers of the famous Servel Refrigerator

SERVEL, INC. Evansville 20, Indiana

All these Valves . . from One!

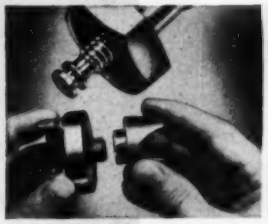
Valve combinations for 90% of industrial piping assembled with 4 bodies and a handful of parts.

Fig. 106-A
Renewable Composition Disc

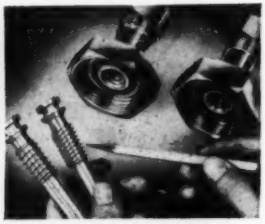
BRONZE GLOBE VALVE
150 lbs. Steam
300 lbs. O.W. G.

JENKINS FIG. 106-A "FAMILY"

Start with the standard Fig. 106-A. Trimming is interchangeable in Globe or Angle body, screwed or flanged.

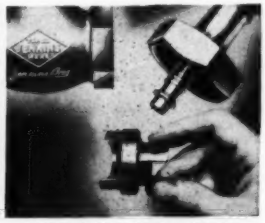


For Close Control — In throttling service, the nut which holds the disc in the disc holder is removed and replaced with Throttling Nut, Fig. 344.



For Quick Opening and Closing — Merely substitute the bonnet and spindle from Fig. 941, in which threads are pitched more sharply.

For Lift Check Service — Globe or Angle Bodies can be fitted with interchangeable Cap, Disc Holder, and Guide Disc Nut from Fig. 117A. Addition of spring from Fig. 655A provides spring loaded service.



For Stop & Check Service — Use the 106A trim, but substitute this spindle from Fig. 630A and replace the regular disc nut with the check valve guide disc nut.

Look over these pictures and see how easy it is to make up just the valve type you need, simply by interchanging parts. Think of the saving this means in maintenance expense . . . in reduced inventory of spare valves in your stockroom.

That's a big reason why the Fig. 106-A series takes top honors in any poll for valve preference. And Jenkins time-proved design, makes them the longest-lasting, lowest-upkeep valves that money can buy.

For example, see the heavy construction of the one-piece, screw-over bonnet. You can remove and replace it over and over again without distortion. See the extra size packing box,—and the perfectly machined threads on the heavy manganese bronze spindle, with more threads in contact with the bonnet, open or closed.

Remember, Jenkins Bros. is the originator of the renewable composition disc valve,—the *only* manufacturer of both valves *and* discs. For drop-tight, trouble-free performance, get acquainted with the Fig. 106-A "family". Despite their extra value, *you pay no more* for Jenkins Valves. Jenkins Bros., 100 Park Ave., New York 17, N. Y. Jenkins Bros., Ltd., Montreal. Sold through leading Industrial Distributors.

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VALVES
SINCE 1864 TRADE JENKINS MARK

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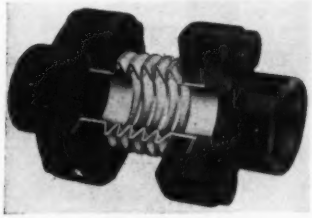
New Equipment *Business Notes* *Latest Catalogs*

Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

New Equipment

Bellows Connector

Fabricated of chemically inert Teflon, the new "John Crane" bellows-type connector, made by Crane Packing Co., Chicago, Ill., has many pipe-line applications where vibration, expansion, and electrolysis exist in the handling of corrosive liquids or gases and solvents. The new connector is electrically nonconductive, flexible even at −94 F and as strong at 480 F as at 70 F, according to the manufacturer.



This bellows connector serves as a vibration dampener as well as an expansion joint—connects misaligned couplings and insulates flanges electrically. End flanges of the joint are French-type envelope gaskets made integral with the joint for easy assembly between companion flanges and a tight, leak-proof seal on installation.

Twist Drill Tips

Recent developments in the techniques of drilling cast iron with carbide tipped twist drills and the resultant increasing demand for such twist drills has now led to the addition of a line of standardized twist drill tips for cast-iron drilling to the line of blanks carried in stock by Carboloy Dept. of General Electric Co., Detroit, Mich.

Standard tips, ranging in size from 1/4 through 1 in. (nominal diameter) in 1/16-in. steps are of grade 44A. Other sizes are available on special order.

When twist drills are tipped with carbide in this manner, rate of drill penetration can be doubled and still obtain a life of 3 or 4 times that of the untipped drill. When operated at the same speed as steel twist drills, the tipped drills give around 10 times the tool life, according to field reports.

Standard twist drill tips of grade 883 carbide for drilling nonferrous materials are also carried in stock in 23 sizes, including the same sizes now available in 44A.

Aluminum Coating

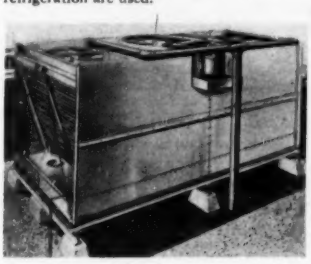
New hard coatings for aluminum where high resistance to abrasion is desired are being released to licensees by Aluminum Co. of America, Pittsburgh, Pa. These coatings are said to have special value where hard, long-wearing surfaces coupled with lightweight are essential, as in surfaces subjected to abrasion or erosion. They have been used extensively in aircraft equipment and orthopedic appliances.

The new wear-resistant finishes are anodic oxide coatings which form an integral part of the metal they protect. Intrinsically hard, aluminum-oxide coatings cannot be chipped or flaked from their parent metal, and the newer types afford superior resistance to abrasive action. Some of these wear-resistant finishes are made by the well-known Alumilite process.

Alcoa has also acquired the U. S. patent rights to the Martin hard coating for aluminum from The Glenn L. Martin Co., of Baltimore, Md. The MHC finish is similar to the Alumilite coatings in hardness and structure.

Double-Flow Aquatower

A new double-flow aquatower, made by Marley Co., Inc., Kansas City, Mo., is a water-cooling tower for use wherever intermediate capacities of cold water are required. Cooling towers in this range are widely used in the power, petroleum, gas, chemical processing, food processing, and metalworking industries, and wherever air conditioning and refrigeration are used.



Outstanding features of the new tower are as follows:

1 Its height (only 7 1/3 ft for the 150-ton unit) is lower than that of any other cooling tower of similar capacity.

2 Pumping head and required fan hp are extremely low for any given capacity and design performance.

3 It is the first water-cooling tower in the "medium-capacity" range to use the patented double-flow principle—one fan utilizing air from two completely open sides.

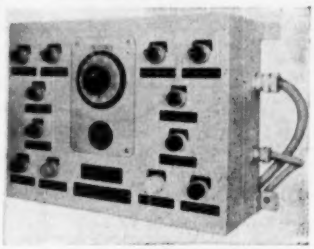
4 Tower weight is evenly distributed over a wider area than that of any other cooling tower of similar capacity.

5 Tower design simplifies maintenance and inspection. All parts—piping, nailless redwood filling, basin fixtures, fan and motor, distribution basin—are readily accessible.

The new double-flow aquatower comes in seven standard sizes, starting with a 50-ton unit. It is available in all steel or wood with asbestos cement board casing.

Automatic Weighing

Through application in a novel manner of a simple servomechanism, extensively used in processing controls, the Richardson Scale Co. of Clifton, N. J., has developed, the Select-O-Weigh, an automatic cumulative and consecutive weighing system.



Heart of the Select-O-Weigh is an electronic circuit with no arcing contacts, making it perfectly suited to explosionproof installation. A standard type Richardson automatic scale is used as the weighing element in the system, with a pendulum dial scale acting as the force-measuring component.

The Select-O-Weigh system operates in the following manner: A master control panel for any particular system is built to include as many setting dials as there will be ingredients in formulas handled—one dial for each ingredient. (It is possible to operate a Select-O-Weigh system for from 2 to 12 ingredients.) The scale operator, who may be located in any part of the plant remote from the actual weighing operation, sets each dial on the control panel to correspond with the amounts of each ingredient in his formula. Sequence of adding materials and their timing are selectively controllable.

After setting up the control panel, the "start" button is depressed. This actuates the screw feeder mechanism, delivering to the scale the amount of material set on the first control dial and then stopping. This action is visible on the scale dial. Then, depending upon the settings of the various selections and controls, the scale either discharges to a mixer or goes on to the next ingredient, repeating the cycle and adding this ingredient

PROBLEM:

Stop Ignition Cables from Burning Out!

This natural gas collector pumping station was out of service at least one day out of every 30, causing a costly loss in gas production. Heat from the gas burning motor charred and cracked the organic rubber insulation on the ignition wires. Leakage of the high voltage spark led to misfiring and failure of the motor. Added to the loss in gas production was the continuous replacement cost of the ignition cables.

SOLUTION:

SILASTIC°, the Dow Corning Silicone rubber.

Ignition cables insulated with Silastic were installed because this Silicone rubber will withstand long exposure to temperatures ranging from —100° to over 500°F.

RESULT:

No Ignition Cable Burn-outs in 2 Years.

The Silastic cables have been in use for 2 years; will probably last the life of the motor. That means reduced maintenance costs, uninterrupted performance and full capacity gas production.

Silastic has high thermal conductivity and excellent dielectric properties over a wide range of frequencies. Silastic remains soft and pliable in sub-zero temperatures, and resilient after long contact with hot oil at temperatures in the range of 400°F. That's why design and production engineers specify Silastic for hundreds of applications where other resilient materials are subject to rapid failure.

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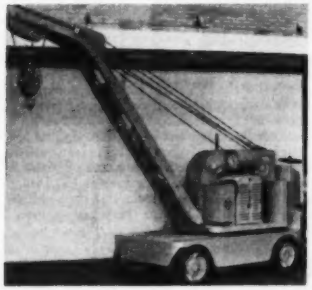
to the weigh hopper in the amount indicated by setting on the second control dial. Again, the pointer on the dial moves to its new position, as the material is added, and stops the action. Control circuits may be so arranged as to provide either (1) delivery of consecutive weights of varying amounts according to a predetermined schedule, or (2) accumulation of a total batch of a preselected formula and its discharge to a surge hopper or mixer as a whole.

Following discharge of the automatic scale, a tare check circuit is brought into operation to prevent the scale from initiating the next weighing unless all material is cleared from the weigh hopper and the unit is in perfect empty balance. This is accomplished by electrically verifying the repositioning of the dial scale pointer at exact zero or empty balance position.

A further elaboration of the system is the operation of repeater dials to indicate remotely the position of each scale pointer.

Flexible Industrial Crane

Many industrial plants, warehouses, and shipping terminals have frequent calls to move equipment or material which does not lend itself to conventional handling methods using a fork or platform truck. Often this occurs in outdoor storage or other areas not serviced by overhead cranes. An electric-powered, mobile crane introduced by Elwell-Parker Electric Co., Cleveland, Ohio, and known as Model CZ can be the answer to this problem. It has recently been redesigned with a wider bed and higher operator control pedals for better forward visibility.



Design features include four-wheel steer; telescoping boom to provide boom lengths of from 12 to 19 ft; silent, efficient worm drive; heavy welded steel frame; and three individual motors with solenoid-operated brakes for powering slew, hoist, and boom. Conventional wheel steer is standard but electric power steer is recommended when heavy loads are to be handled. Power is supplied by either an electric storage battery or gas-electric unit.

Crane capacity is 10,000 lb at 5 1/2 ft radius. With the boom fully extended to 19 ft, a hook height of 18 ft can be obtained. Over-all length and width are 130 7/8 in. and 66 3/4 in. respectively. The truck turns in 95-in. intersecting aisles. Maximum slew is 296 deg.

When required, outriggers for increased over-the-side capacity can be installed and remote control of the boom, hook, and slew from the load end can also be provided. The crane can be equipped with an electromagnet for handling bulk ferrous materials.

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for dependable, accurate liquid level control!
Controlling the liquid supply to open tanks is easier and more dependable when you do it with Keckley balanced float valves. They're engineered to give you long service with minimum maintenance—and protect you against costly failures that disrupt processing operations. The balanced feature insures constant even flow and positive closing action regardless of the incoming pressure. Keckley float valves are available in sizes from 1/2" to 12". Screwed, standard or extra heavy flanged connections.
• No. 15 Balanced inner valve double seat. Pressures to 125 lbs.
• Specify No. 14 single seat float valve where tight closing is required.
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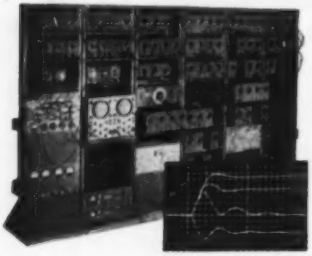
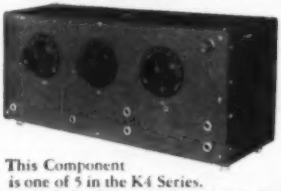
HOW YOU CAN "BUILD" AN
AUTOMATIC ELECTRONIC
Analog Computor
WITH THE GAP/R SERIES OF
Components



Perhaps you need an assemblage this size for solving 36th-order differential equations, or possibly the equipment in the left-hand rack alone will suffice. In either case your "building blocks" are provided by our standard *Computing Components*, of which two examples are illustrated below. Here, for example, is

MODEL K4-DY



This Component is one of 5 in the K4 Series. Called the *Dynamic Component*, it embodies a 2nd-order linear operator with all parameters adjustable. Also available: the double *multiplier*, the *controller*, and two completely flexible components for *non-linear functions*. More elementary, but highly versatile, operations are incorporated in the Components of the K3 Series, such as

MODEL
K3-E

This is an *Augmenting Differentiator*, which performs a 1st-order linear operation having one adjustable parameter. There are 12 other models in this same size, including those for such other linear operations as *addition, integration, retardation*, and for setting *coefficients*. Examples in the non-linear class are Components for *bounding, squaring*, and computation of *absolute value*.

Investigate!

These little "black boxes", and the computing systems easily assembled from them, can magnify your brainpower and diminish your time scales They are fast, accurate, economical, and ready & willing to work (on *your* problems).

George A. Philbrick Researches, Inc.
230 Congress Street, Boston 10, Mass.

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Overload Release

An overload release for the Dodge torque-arm speed reducer, which provides instant and positive protection for driven machines, motors, and the speed reducer itself, has been developed by the Dodge Mfg. Corp., Mishawaka, Ind.

Designed to prevent breakdowns, avoid expensive repairs, and insure against interruptions of production resulting from any excessive load on the equipment, the new product has been named the Dodge Tri-Matic overload release because of the triple protection which it affords. The release operates both mechanically and electrically to (1) loosen the belts, (2) cut off the current, and (3) activate a warning bell, siren, or light.

The release acts instantly and positively. Pressure exerted by an excessive load causes a piston to move lengthwise through the unit and this movement loosens the belts and cuts off the current simultaneously. The warning system is hooked up to the microswitch.

The Tri-Matic is calibrated for adjustment to the load conditions of any job. It can be set to act at any desired load up to the reducer's maximum capacity.

To reset the Tri-Matic after it has been tripped it is easy to pull the speed reducer back manually into position. This automatically cocks the overload release mechanism.

Gasoline from Coal

Power and process steam for the first commercial plant for making high-octane gasoline from coal will be supplied by four large boilers, contract for which has been placed with Combustion Engineering—Superheater, Inc., New York, N. Y. The plant is being built for the South African Coal, Oil and Gas Corporation, Ltd. (SASOL) and will be located near Johannesburg, South Africa.

The project is an international undertaking to an unusual degree. The M. W. Kellogg Co., New York, N. Y., will act as over-all project managers and will be responsible for the design and engineering of process facilities which will include their newly developed Synthol process of synthesis. Part of the engineering and manufacturing of the process facilities will be done by German firms, and the engineering of the power facilities has been assigned to a Belgian firm. Combustion Engineering as the prime contractor for the boilers will subcontract some of the manufacturing to affiliated companies in France and South Africa. This distribution of the work will not only expedite construction but will help to meet problems of dollar exchange and material shortages.

Each of these boilers will be capable of producing 370,000 lb of steam per hr at 700 psi, 800 F, and will burn South African coal in pulverized form. This coal, as received, runs about 30 per cent ash and 25 per cent volatile, and has a heating value of around 13,000 Btu per lb.

Helical Thread Inserts

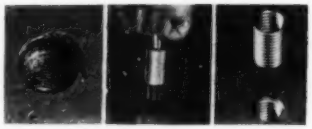
Helical-wire thread inserts are speeding the repair of worn and stripped bolster-plate threads in the machine shops of Stewart-Warner Corp., Chicago, Ill., according to Heli-Coil Corp. of Danbury, Conn. Conservative estimates place time savings at more than 80 per cent compared with conventional methods.

Repair operations follow this pattern:

1 The damaged thread is cleaned out with a drill slightly larger than original thread's major diameter.

2 The hole is retapped with a standard Heli-Coil tap.

3 A stainless-steel Heli-Coil insert is installed, bringing the hole back to original thread size.



After the bolster plate is properly positioned in a drill press, the badly worn $^{5}/_{8}$-11 thread is cleaned out with a $^{21}/_{32}$-in. drill. Retapping is accomplished with a $^{5}/_{8}$-11 Heli-Coil tap. Tap sizes are keyed with the original thread size to speed and simplify identification.

After tapping, a $^{5}/_{8}$-11 Heli-Coil thread insert is installed with an inserting tool and is positioned so that the top coil is one half turn below the surface of the plate. Because this is a through hole, the inserting tang—an extension of the lead coil bent inward along a diameter to engage the slot in inserting tool—must be broken off after the insert is installed. This is accomplished with a tang break-off tool. On blind holes, the tang is left intact because Heli-Coil inserts for this type of hole are specified to lengths prohibiting interference between bolt and tang.

Continuous Annealing Line

At a rate of 1000 fpm, cold-reduced steel strip for tin and black plate products is cleaned, annealed, and recoiled in a new continuous annealing line at U. S. Steel's Sheet and Tin Mill at Gary, Ind. The line is housed in a new building 336 ft long with a ceiling height of 76 ft.

With an annual capacity of about 136,000 net tons, the line will process strip ranging from 0.0075 to 0.015 in. thick and in the usual tin-plate widths. From beginning to end, about 3000 ft of strip are in process through the line at one time.

Coils from 30 to 66 in. in diam, weighing from 5000 to 30,000 lb, are delivered to the annealing line from the five-stand tandem cold-reduction mill. They are fed into the line alternately from two uncoilers.

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The operation is made continuous by welding the entering end of each new coil to the end of the preceding coil. A double-cut shear squares the ends for welding. Ignitron controlled, the welder makes two closely spaced seam welds across the full width of the strip in one transverse pass. Welding time is 3 sec. Time for entire change of coils is 12 sec.

After leaving the welder the strip passes through an edge scanner which provides a signal to the entry end and line operators when strip with defective edges is entering the line. Motor-driven pinch rolls serve both to position the strip for welding and as a holding bridle when welding with the rest of the line in operation.

The strip next enters the cleaning section of the annealing line. In a tank containing a hot alkaline solution, the strip is cleaned electrolytically. It then enters the scrubber section, where rotary scrubbing brushes and pressure sprays complete the cleansing operation. Through exit wringer rolls the strip passes into a hot rinse unit and then through a hot-air dryer.

The heat-treating section of the new continuous annealing line consists of a heating zone, a holding zone, a slow-cool zone, a fast-cooling tower and a final-cooling zone. From initial heating and up to final cooling, the entire annealing process is accomplished in a protective atmosphere to prevent oxidation.

Following the heat-treating section the strip passes through the exit pulling-roll bridle, which consists of two individual motor-driven rolls. These rolls pull the strip from the entry pulling-roll bridle through the heating and cooling units and maintain correct tension throughout the process. This tension at high temperature has a stretch-leveling effect on the strip, producing a flat, even product.

At the exit end of the line is a duplicate of the entry looper, working with a minimum length of stored strip, but capable of storing 316 ft when the delivery end of the annealing line is stopped to change and discharge coils.

Spinning Machine Drive

The General Electric Co. has announced development of a new drive for spinning machines that is designed to provide greater uniformity of denier and dye-ability of synthetic yarns than ever before obtainable.

This all-a-c drive insures uniformity through the most precise speed control (one tenth of one per cent over a 7:1 speed range) ever obtained for spinning machine motors, according to G-E engineers.

The system utilizes an electronically-regulated a-c adjustable-speed motor, which drives a variable frequency alternator through a two-speed, herringbone gearbox. The alternator output is delivered direct to small synchronous motors on the spinning machine. These motors, in turn, provide direct drive to the machine positions, and eliminate troublesome and costly gearing, tapes, and line shafting.

Requiring only about two-thirds of the floor space needed for a comparable d-c drive, the new system provides greater operational efficiency with fewer electric machines. Lower maintenance expenses and savings in power consumption are other major advantages.

The first of these new G-E drives was installed recently in a southern plant. Twenty others now are being built to order, G.E. said.

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BRAKES—HYDRAULIC—Smooth, positive action for safe operation—ruggedly built for long-lived efficiency.

To meet the varying needs of users, CLARK electric fork-truck motors are designed to operate efficiently on any power supply from 30 to 48 volts. CLARK'S standard power supply is 36 volts. These trucks are designed with perfect balance among all components and incorporate a new method of motor winding which provides more efficiency than has ever been offered in an industrial truck motor . . . There have been many technical changes from year to year in CLARK machines, but there has never been any change in CLARK'S 30-year purpose to give you the best VALUE your money can buy—and there never will be.

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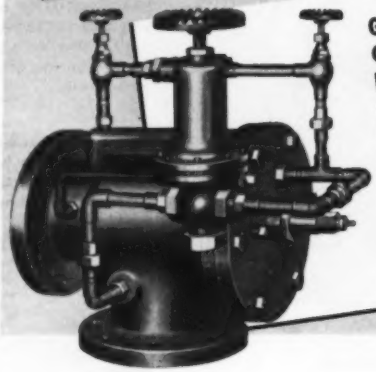
GOLDEN-ANDERSON CUSHIONED WATER PRESSURE REDUCING VALVE

Used to protect water lines where high initial pressures would cause serious damage to distribution mains, this very sensitive valve will maintain a uniform delivery pressure. Bulletin W-3 will interest you.



GOLDEN-ANDERSON CUSHIONED SURGE RELIEF VALVE

This valve is used to protect water lines against excessive pressures caused by surges in the system, and will open immediately when inlet pressure exceeds the adjustment of the pilot. Bulletin W-2 sent on request.

For over 50 years, Golden-Anderson has specialized in designing and manufacturing pressure control valves. The patented air and water cushioning feature effectively prevents any bang or hammer.

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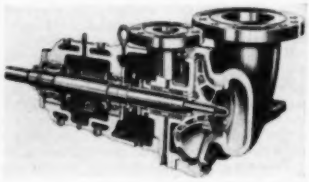
Process Pump

To pump petroleum hydrocarbons, water, and chemical solutions at elevated temperatures and pressures, Peerless Pump Div., Food Machinery and Chemical Corp., Los Angeles, Calif., has recently introduced a new process pump, designated as the Peerless Type PR.

General characteristics show that the Type PR pump provides capacities up to 1000 gpm and operating heads up to 625 ft. Temperatures of liquids pumped can be up to 850 F. Horizontal electric motor drive is standard but others such as steam turbine or stationary engine can be furnished. The pump's liquid end can be furnished in cast iron, bronze, carbon steel, stainless steel, or other materials as required by intended application or service. Two models are offered, one with top suction—top discharge, the other with end suction—top discharge, to suit existing or planned piping arrangement.



Construction features are as follows: The center-line-mount design maintains pump alignment at any temperature. The positive support beneath the pump case prevents strains being imposed on the rotating parts, adding to both bearing and packing life. The vertically split case, with single joint, and a fine metal clad gasket insure tightness against loosening or leaking. All internal joints have been eliminated when differential pressure across them would cause leakage or corrosion. Water-cooled stuffing box has in-and-out water cooling connections, removable throat bushing, by-pass lantern to relieve pressure back to the suction and a quench type packing gland to provide protection against the escape of hazardous liquids through the packing. Slingers and specially recessed bearing caps both inside and outside of both ends of the bearing housing are designed to prevent oil leaking out of, or any kind of dirt entering into the housing.

The Peerless Type PR pump is described and illustrated in a new bulletin No. B-1605, available from the company.

Profilograph

Some time ago The Timken Roller Bearing Co. of Canton, Ohio, developed a machine which could determine with extreme accuracy just how rough or how smooth a steel surface was. Recently, Timken engineers have added a further refinement to this machine. With this new development, it is said to be possible to determine if a ground circle is perfect or not. (With this new development both surface finishes and geometry are checked within a millionth of an inch.)

Called a Profilograph, the machine works as follows: The surface of the object to be measured is mounted on a flat, delicately adjusted table which is fitted into a special bearing. A highly refined hinge is mounted just above the specimen for measurement. At the end of this hinge is a diamond needle

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and a tiny mirror. The diamond needle traces ever so lightly over the surface of the object as the complete table upon which the specimen is mounted turns. As the needle rides over the surface, any variation in that surface wiggles the needle, and also the tiny mirror mounted on the same hinge as the needle. A tiny beam of light is played on the mirror and as the mirror moves, the beam of light moves also. Through a series of other mirrors, the light beam is transmitted onto a photographic film and the variations on the surface of the object being measured are recorded on a circular film. It is this instrument that can tell the initiated just how rough or how nearly perfect are Timken tapered roller bearings. By changing the length of the light beam, surface variations can be magnified up to 5000 times their actual size.

Window Air Conditioner

A new, low-priced 1/3-hp window-sill room air conditioner, embodying the same engineering, construction, and design standards featured in Carrier's established line of 1/2 to 1 1/2-hp models, has been announced by Carrier Corp., Syracuse, N. Y.

The new model is in production and will go on display immediately at most Carrier dealers throughout the country.

The unit was developed to meet a growing demand for small offices, bedrooms, and other spaces where cooling loads do not require larger-capacity equipment. Except for price and capacity, it was stated, the 1/3-hp room air conditioner will be similar to Carrier's other models in every respect, including vibrationless hermetic compressor, streamlined heavy gage cabinet, and five-year warranty.

Simplified fingertip controls can be set for cooling and dehumidification with either outside or room air, or for ventilation only with filtered outside air.

13,200-Ton Extrusion Press

A giant extrusion press—said to be the largest in the nation—is being installed at Aluminum Company of America's Lafayette, Ind., Works.

Leased from the U. S. Air Force, the new extrusion press exerts a force of 13,200 tons.

In terms of national defense the press means that larger, lighter, more intricate aluminum shapes can be produced by extrusion for aircraft and other industries.

Ribbed airplane wing panel extrusions, for example, may be made in lengths up to 90 ft. Ribbed panel extrusions of such size and shape mean that a plane may have a stronger skin with less weight. The wider shapes also

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Bigelow Types F, FH and FHC boilers are available in capacities from 20,000 to 100,000 pounds of steam per hour. Design pressures range from 160 to 450 lbs. p.s.i. These boilers are designed for oil, coal, gas or combination oil and gas firing.

For further information on any of the boilers listed write for free catalogs or contact your nearest Bigelow representative.

BOILERS BY BIGELOW
Water Tube Boilers — Bent Tube Types
Horizontal Return Tubular Boilers • Scotch Type Boilers
Two-Pass Boilers • Electric Steam Generators

One of the two Bigelow Type FHC Boilers installed recently at a midwest refinery. Installation is semi-outdoor with the firing fronts of the boilers inside the building.
Capacity — 40,000 lbs. each. Design pressure 250 lbs. Fired by combination #6 oil and gas burners. Boiler furnace side walls are completely water cooled. Roofing is tile, insulating block and plastic.

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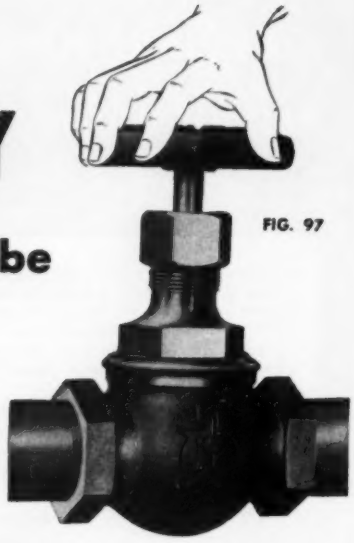

FIG. 97

JOB-FITTED with the *right* disc for every service

FIG. 98

TO ASSURE LONG, TROUBLE-FREE OPERATION with easy maintenance, the complete KENNEDY Line is *job-fitted* . . . every valve specially designed and engineered for the job it has to do.

IN THE KENNEDY FIGS. 97 and 98, for example, the disc is exactly matched to the job. To meet a wide range of fluid, temperature and pressure requirements, a variety of disc materials is available. Each is carefully selected for the service for which it is recommended.

THE RENEWABLE COMPOSITION DISCS give longer service because the extra height of the raised seats utilizes full thickness of the disc before replacement is necessary. The disc holder swivels on the stem to allow uniform wear on the disc.

THE MOLDED PACKING is self-lubricating and both Fig. 97 and Fig. 98 can be readily repacked under full pressure.

THE HEAVY-WALLED BODIES are ruggedly built with full rounded contour. The stems are made with manganese bronze of 50,000 lb. tensile strength and have unusually heavy threads. Parts are fully interchangeable. Sizes range from ¼ to 3 inches with a working pressure of 125 lbs. saturated steam, WRITE FOR BULLETIN 56.

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reduce weight and production costs by reducing the number of rivets needed.

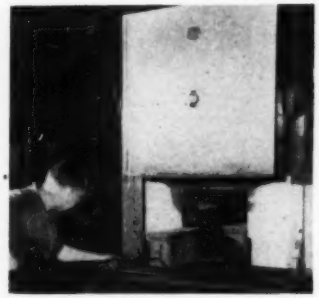
The new press is by no means restricted to aircraft parts. Its versatility is as great as that of the extrusion process itself.

It is possible to produce large strong-alloy shapes for the aluminum-conscious marine industry, for example. Large shapes for railroad car, bus, truck, and trailer construction also can be produced. Wide thin shapes for building curtain walls are likewise possible. Large extruded pipe for petroleum and other pipe lines is still another possible use for the powerful new press.

As an indication of the potentialities of the new press, Alcoa will be able to quadruple the weight of its extrusions from 600 lb per piece to 2300 lb. While maximum length of extrusions remains at 90 ft, the size which can be produced in that length increases from 6.7 lb per ft of length to 25.5 lb, or from 5.6 sq in. in cross-sectional area to 21.3 sq in. Maximum circumscribing circle diameter for shapes may increase from the present 14 in. to 23 in.

Electric Furnace

A technician removes dental forgings from a General Electric box-type furnace at S.S. White Dental Mfg. Co., Philadelphia, Pa.



Use of this furnace and another similar to it has resulted in faster production, fewer rejected pieces, and more uniform hardness of the tools, according to White engineers.

The 220-volt model shown has a temperature rating of 1850 F and a capacity of 200 forgings a day of both carbon and stainless steel. The forgings are heated for eight hours and then allowed to cool overnight before being removed.

Drum Sander

A light balanced polishing wheel that assures low-cost operation on many applications has been announced by the Carborundum Co., Niagara Falls, N. Y. Called the Cone-Loc drum sander, it is said to be a practical and efficient means of cutting abrasive costs of polishing operations to a bare minimum.

Short strips of coated abrasives torn off standard "economy" rolls are secured in place in a jiffy around the drum sander. When the arbor nut is run up tight against the locking cone washer, the wheel becomes the same as a solid wheel—smooth operating, perfectly balanced, and no bounce at the joint. Rubber cushioned Cone-Loc drum sanders are precision ground at high speeds to overcome effects of centrifugal force.

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Knock-Down Shop Stool

A new knock-down shop stool, adjustable in three sizes to 15 positions and designed to be shipped and stored economically, is being made by Standard Pressed Steel Co., Jenkintown, Pa.

The stool has a welded seat assembly, double-angle leg construction for strength, and an automatic nut-locking feature.

One size is adjustable from 18 in. up to 22, a second from 23 to 27, and the third from 28 to 32, all by 1-in. steps. The adjustment can be made simply with four small bolts.

The steel seat, 14 in. in diam, can be had with masonite top. The stool comes equipped with pressed-in glides at the ends of the legs. Rubber tips can be had. A back which is adjustable for height and for angle is also available.

12,000-Hp Electric Drive

A modern electric drive will replace a famous old steam engine in operating the record-making Aliquippa, Pa., blooming mill of the Jones & Laughlin Steel Corp.

The 12,000-hp electric unit, now being built by the General Electric Co. at its Schenectady, N. Y., Works, will be the nation's most powerful reversing mill drive for converting ingots into blooms, it is reported. It will replace the 40-yr-old steam giant that powered the mill to a world production record (183,728 tons rolled from five-ton ingots) during March, 1949.

The double-armature twin-reversing main drive for the 44-in. mill will consist of two 6000-hp, double-armature motors, each driving one of the two work rolls. Operating on 750 volts, these d-c motors will have a speed range of 70 to 140 rpm.

Amplidyne control will provide near-instantaneous response in accelerating, decelerating, and reversing. The motors will be capable of reversing at the 70-rpm "base" speed in approximately one second.

A 12,000-kw flywheel motor-generator set with liquid slip regulation will supply power to the motors. The M-G set will consist of a 9000-hp wound rotor induction motor; four 3000-kw, d-c generators; and a cast-steel flywheel with a stored energy of 250,000 hp-sec at 360 rpm. Nearly 16 ft in diam, the flywheel will be more than 2 ft thick, and will weigh 91½ tons.

High-Voltage Impulse Testing

A considerable simplification in the impulse testing of high-voltage equipment is achieved through the use of the Du Mont Type 293 cathode-ray oscillograph, manufactured by the Instrument Division of the Allen B. Du Mont Laboratories, Inc., of Clifton, N. J.

Employing a sealed-off, hot-cathode, cathode-ray tube, the Type 293 is packaged as a single, mobile console. The Type 293 eliminates elaborate preparation of the oscillograph or recording materials. The only limitations upon the speed with which successive tests may be made are those imposed by

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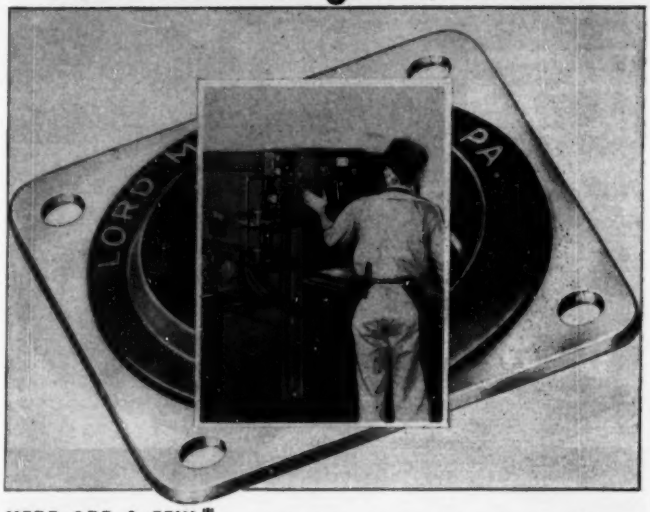
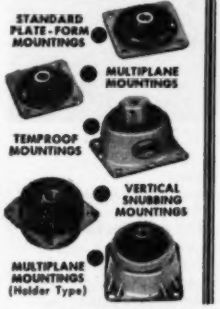


HERE ARE A FEW LORD MOUNTINGS DESIGNED FOR ELECTRONIC INSTALLATION



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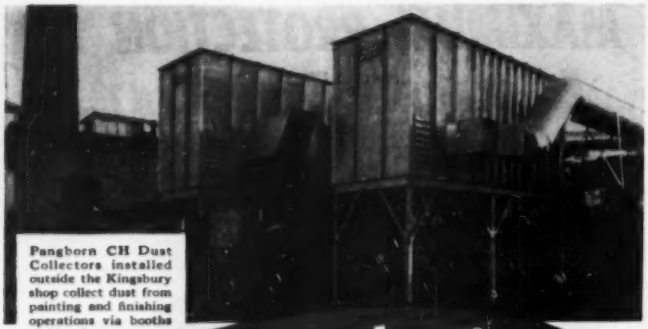

Pangborn CH Dust Collectors installed outside the Kingsbury shop collect dust from painting and finishing operations via booths and hoods.

One Pangborn Installation Solves 6 Dust Control Problems!*

Hoods exhaust dust from hand polishing and grinding booths to outside Collectors

FINISHING operations at Kingsbury Machine Tool Corporation presented a 6-fold dust control problem to Pangborn engineers. Several priming, lacquering and spray painting operations had to be protected from dust created in other finishing jobs such as snagging, grinding and smoothing.

To control these dusts efficiently, Pangborn recommended booths, tables and exhaust hoods. Four main booths, four snagging tables, one snagging bench and a bench grinder hood control the dust at the source. All these are exhausted to two CH Collectors located out-of-doors.

Kingsbury reports the complete system "highly satisfactory"—with these added benefits: Heating costs have been lowered substantially through recirculation of the cleaned air. Costly dust damage to adjacent machinery and products has been prevented. And workers' efficiency has increased due to cleaner working conditions.

What are your Dust Problems? Find out what Pangborn can do to solve them. Write today for Bulletin 909A. Address: PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Md.

Look to Pangborn for the latest developments in Dust Control and Blast Cleaning equipment

Pangborn DUST CONTROL

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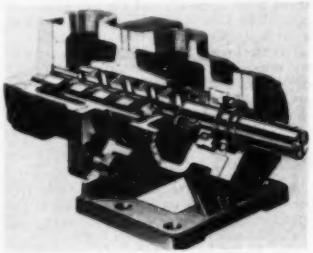
the test facilities and by the equipment under test. A specially designed 35-mm recording camera is supplied as a component part of the Type 293, or a camera having an object-to-image ratio of approximately 1 for full-scale records may be selected.

Owing to the great flexibility of operation of the Type 293, as well as its mobility, this new instrument is applicable not only to conventional laboratory impulse test programs, but also may be used economically for production testing of high-voltage equipment.

Low-Cost Pump

A new De Laval-IMO A313B pump, which saves up to 40% in initial cost over other IMO models for similar pressures, has been announced by De Laval Steam Turbine Co., Trenton, N. J. This IMO is designed to handle a wide variety of oil handling applications for pressures up to 275 psi.



The new rotary positive displacement pump offers all the advantages of the IMO design. It has only three moving parts. It is reliable, quiet, pulsation-free, compact, excellent for high-speed operation. It can be used for capacities to 80 gpm, pressures to 275 psi, and intermittent pressures up to 325 psi. This new IMO handles light or viscous fluids in hydraulic systems, rotary and steam-atomizing oil burners, lubrication, governing systems, and similar services.

Bulletin No. L313B, which fully describes this new IMO pump, is available on request from De Laval Steam Turbine Co.

Document Reproduction Paper

A new document reproduction paper designed to provide the best results in the reproduction of extremely fine detail has been announced by the Eastman Kodak Co., Rochester, N. Y.

The new paper, Kodagraph contact fine-line paper, is expected to prove especially valuable for reproducing originals with very fine detail, drawings and documents in poor condition, and printed half-tone originals. In addition, the company claims that it will make the highest quality negatives from which top quality cloth prints or offset plates can be produced if desired.

The paper has a glossy surface, a rich look and "feel," and produces lines which are crisper, and characters which are cleaner and more open. It produces photocopies which are unsurpassed for legibility and over-all appearance, according to the makers.

Fine-line paper has the same wide latitude, the same practical speed, and the same uniformity as other types of Kodagraph contact paper. It is suitable for use with all types of contact photocopying equipment and will be available in a wide range of standard sheet and roll sizes, in "thin" weight.

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KEL-F Gaskets

One of 600 destined for a large chemical plant, these 45-in. solid KEL-F disks weigh 16 lb, are 0.125 in. thick, and are held to a tolerance of ±0.005 in.

They were fabricated from KEL-F, M. W. Kellogg's polytrifluorochloroethylene resin, by the United States Gasket Company's Fluorocarbon Products Division at Camden, N. J., which also has produced fluorocarbon-jacketed gaskets up to 12 ft in diam.

In addition to the manufacture of sheets, this company extrudes rods, tubes, and bars, injection molds and fabricates all types of fluorocarbon products for the chemical, processing, electronic, nucleonic, and food industries.

Airfoil Blading

Witness tests in Westinghouse's Sturtevant Div. Air Handling Research Laboratory were recently completed on a scale model of a new centrifugal fan wheel with airfoil blading. The tests strikingly demonstrated the mechanical efficiency of airfoil blading—92 per cent compared to 84 per cent for conventional bladed fans. In addition, this new fan is considerably quieter—developing 65 per cent less noise energy than conventional fans, it is reported.

Ordinarily the blades of centrifugal fans are simple rectangular metal plates—flat or curved—welded in the rotating element. In the case of the airfoil fan, the blade cross section is similar to that of an airplane wing cross section—teardrop shaped and curved backwards from its direction of rotation. Such a blade exerts positive pressure on the air over its entire face from the leading edge to the trailing edge. As a result, air flow is smooth with a minimum of turbulence.

Airfoil blades are more costly as each is a hollow steel shell with supporting struts welded longitudinally inside. The higher efficiency of this fan makes the construction worthwhile as the savings in horsepower during the write-off life more than repays the small premium in first cost.

Metal-Clad Switchgear

A new standard line of metal-clad switchgear, ranging in ratings from 2400 to 13,800 volts, 150 to 500 mva, has been announced by the General Electric Co., Schenectady, N. Y.

One of the new design improvements is in the magne-blast circuit breaker, in which a

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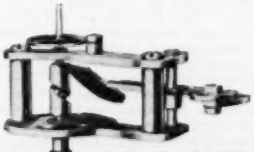

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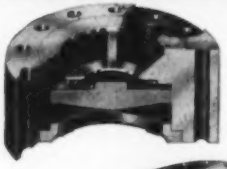

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maximum number of parts are interchangeable among breakers of different ratings. For example, solenoid mechanisms and many contact and arc extinguisher parts are identical in all ratings.

Another feature is an electromechanical control device, built integral with the breaker mechanism. It is the heart of a control circuit system which is identical for all breakers operated from the same control voltage. Auxiliary switches for noncontrol functions are mounted on the stationary structure of the gear.

A new and improved insulating material having excellent flame-retardant, dielectric and antihydroscopic properties is used throughout the breaker.

Meehanite Foundry Processes

In keeping with a long-established policy of achieving maximum product quality, the De Laval Steam Turbine Co., Trenton, N. J., has completed installation of the Meehanite process controls in their foundry.

The foundry produces about 25 tons of castings daily for such De Laval products as centrifugal and rotary pumps, steam turbines, centrifugal blowers, and worm-gear speed reducers.

Iron castings are frequently the truly vital components of units of this type. As such they must provide superior and definite engineering and design characteristics. The adoption of the Meehanite processes in the foundry results in the ability to produce a series of engineering irons with properties predetermined and adjusted to meet exact specifications.

For example, tensile strength upwards to 50,000 psi can be provided in "as-cast" units while with heat-treatment strengths up to 75,000 to 80,000 psi are achieved. Similarly Brinell hardness ranges, toughness, and ductility may be controlled according to need.

Fundamentally, the Meehanite processes give the foundry a series of scientific methods which permit the regulation of the basic structure of the irons and the properties of the materials are of course, a function of these structures.

Carbide Feed Nozzles

By adding a Carboloy cemented carbide bushing inside the conventional feed nozzle tip for automatic arc welding, the General Electric Co. at their Fort Wayne Works has increased life of the nozzle tips up to 20 times. Wear is no longer a problem, and burning effect is greatly reduced, it is claimed.

In one case where the coiled electrode wire is especially abrasive, brass nozzles had to be replaced 6 to 8 times per week. The carbide-protected nozzles are reported to give a service life of 3 months and better. On other operations where former life had not exceeded 3 weeks, the carbide nozzles are lasting as long as 12 months. In addition to the improved nozzle life, a more uniform narrow weld can now be maintained, as accurate guidance of the wire—formerly difficult once wear developed—is no longer a problem. In view of these several benefits, the use of carbide-equipped nozzle tips has been made standard on about 20 automatic arc-welding machines.

Improvements have been made with Carboloy cemented carbide at two other points in order to further reduce downtime and maintenance cost on arc-welding equipment. A carbide guide ring—added inside the fiber guide which keeps the electrode wire from

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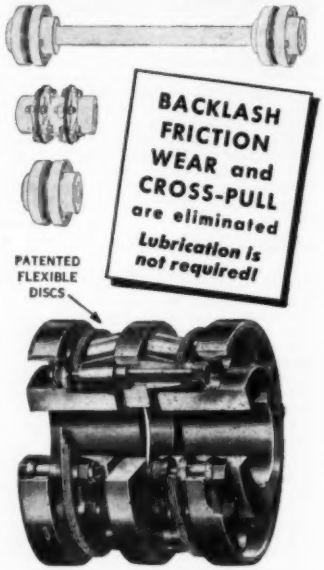

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riding off the overhead pulley—eliminates any possible danger of short-circuits from wire wearing through the fiber insulation and coming into contact with the metal support arm.

The final application was at the guide block which locks the electrode wire in position against the conical feed rolls. When wear occurred at this point, positive feeding was impaired. To eliminate this condition the guide block is now tipped with a standard Carboloy cemented carbide blank. The face of the blank is ground to provide a slight radius.

Materials Handling

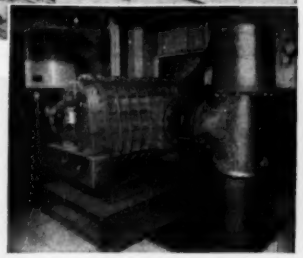
Unloading and moving 800 pieces of heavy machinery from 185 railway cars and 40 highway trucks is no small job. But the fact that it was done in only 27 working days by three Yardlift fork trucks, with the help of a towing tractor, is a record difficult to approach even with a permanent installation of unloading equipment.

This unusual accomplishment took place at the Dowagiac, Mich., plant of the Detroit Engine Div. of Kaiser-Frazer Corp. This plant is being set up for the processing of parts to be used in Wright R-1300 aircraft engines. However, its first job is the servicing and overhauling of machinery which has been warehoused since World War II. This consists of industrial equipment ranging from a single-spindle drill press to the largest Bullard Mult-Au-Matics. The operation involved the unloading of this equipment, moving it to the servicing area, and finally spotting the units at their final locations or reloading them on trucks or railway cars for shipment to other Kaiser-Frazer plants.

When the management of the Dowagiac plant placed this problem in the hands of Emmerson Truck and Storage Co. of Battle Creek, this firm looked to Clark Equipment Co. materials-handling engineers for recommendations. Since the equipment to be moved was generally bulky and heavy, some of it weighing more than 25,000 lb, Clark engineers suggested the use of their Yardlift pneumatic-tired fork-lift trucks. The Yardlift-150 can handle machinery weighing up to 15,000 lb and, working as a team, two of these Yardlift-150's moved the 28,000-lb Mult-Au-Matic with ease and accuracy.

Another unusual problem was solved through the use of the Yardlift-150. Much of the equipment had to be raised to the second floor of the plant for installation. Operating in an open well in the center of the building, the Clark fork truck served as an elevator, lifting a 5½-ton turret lathe and other heavy machinery to a platform on the upper level. From there it was moved on rollers to its installation spot by a Clarkat towing tractor.

Expansion at BRILLO includes: STANDARDAIRE BLOWERS



Installation of Standardaire Blower at Brillo Manufacturing Co.

TO keep pace with the ever increasing demand for Brillo Manufacturing Company products, numerous plant additions have been made since 1913, when the company first started operations. Another million dollar expansion program is now underway—when completed it will provide increased floor space for greater productive capacity. In conjunction with this program Brillo has installed two 105B25 Standardaire Blowers, each having a capacity of 3600 c. f. m. at 1750 r. p. m. These blowers are in continuous round-the-clock service, supplying the necessary air to whisk away the metal turnings incidental to the processing of the famous Brillo pads. Standardaire Blowers are built to take this grueling service in stride. Rigid material specifications and skillful workmanship assure long, trouble-free performance, even when operating under extraordinary conditions. Standardaire Blowers are winning new users every day due to their ability to produce more air in less space with less power consumption.

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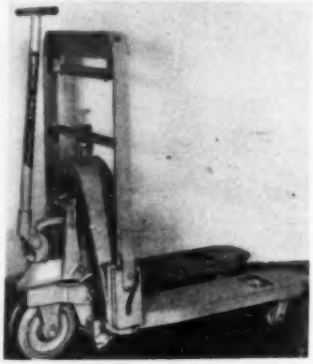
Economies in both time and money effected by the use of Clark equipment on this job have been more than sufficient to convince management that like economies may be expected from Clark fork-lift trucks when the plant goes into actual production.

Hand Lift Trucks

Hand lift pallet trucks from the Philadelphia Division of Yale & Towne Mfg. Co. are now available with a dual-purpose superstructure that will enable them to handle 7- and 12-in. skids as well as single or double-faced pallets.

When the superstructure is in a raised position, it is clamped vertically to provide a backrest for the pallet load on the truck. When lowered, it is adjustable to either 7- or



12-in. skid heights by a simple cam and slot arrangement. Yale feels that this truck will find application in those plants and business establishments where there is not sufficient volume of either skids or pallets to keep a specialized truck for each busy or where flexibility is desired because of varying loads.

The truck is available in either mechanical or hydraulic lifts. Platform trucks can be similarly equipped so that they can handle several sizes of skids.

Oil Mist Precipitator

An oil mist precipitator has been designed by Trion, Inc., Pittsburgh, Pa., to meet the requirements of industry for the elimination of coolant oil mist and smoke emanating from high-speed cutting, grinding, and machining operations. This oil mist and smoke presents a health and safety hazard to plant workers unless properly collected. Oil mist dispersed in the air coats interior walls and machinery, creating a possible fire hazard and necessitating frequent cleaning and increased maintenance. Workers are more liable to falling accidents caused by oil film on floors and machine operators are susceptible to respiratory diseases. An air-pollution problem exists if the oil mist is exhausted to the outside atmosphere and exhaust ducts constitute a fire hazard.

The oil mist precipitator eliminates oil mist at its source. The oil mist or smoke is drawn from the machining operation through ductwork to an inlet adaptor where it passes through a mechanical prefilter and enters a high voltage screen. Here all mist and smoke particles, even of submicroscopic size,

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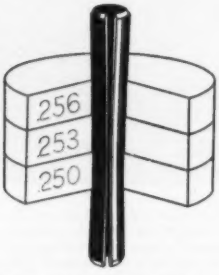
receive a positive electrical charge. These particles are then attracted and adhere to collecting plates, which form the negative elements of an electrostatic field set up between a series of parallel plates, charged alternately positive and negative. The collected droplets agglomerate on the plates and as the accumulation builds up the oil drops off into a collecting basin for ultimate reuse. Under normal machining operations the daily oil recovery from a Trion oil mist precipitator may be as much as 3 to 5 gal.

Complete details are given in catalog No. E-50, available from Trion.

Rollpins

This cross-section diagram of a ring gage, with hole diameters of 0.250, 0.253, and 0.256-in., illustrates the elastic recovery of a standard 1/4-in. Rollpin. One of the important advantages of this all-purpose, pressed fit metal fastener manufactured by the Elastic Stop Nut Corp. of America, Union, N.J., is said to be its capacity to conform to holes of varying diameters because the quick recovery inherent in the Rollpin design permits it to pick up a normal tolerance spread. This characteristic also allows the fastener to join several pieces together much as a rivet—with the important added advantage of being a one-man operation to assemble or disassemble.



The Rollpin, in the ring gage, holds tight against the walls. It thus can pick up backlash, as in linkages, to avoid chatter and to give a constantly tight series of linkages. Designed to provide industry with a replacement for the variety of dowel, pivot, tapered, and grooved pins, most of which require secondary fastening devices, the ESNA fastener has given industrial engineers and designers a high-pressure, shakeproof fastener that eliminates expensive hole-reaming operations. As shown, the fastener is a piece of metal rolled into the shape of a cylinder with a gap or slot which parallels the long axis of the hollow cylinder and is manufactured in fractional sizes from 1/16 through 1/2 in. in diam.

Dust Control

Outstanding economies in bag-house operations where high-temperature dust-control systems are required are being effected through the use of the new Maco-engineered silicone-impregnated glass cloth filter bags which have a temperature range up to 550 F, according to Los Angeles County, Calif., Air Polution Control Commission tests.

The new Maco fabric is one of the developments in the research program conducted in Los Angeles County in a community-wide effort to control smog.

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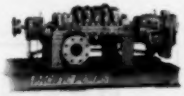
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As part of the control program, the gray iron foundry industry employed independently an engineering firm, Menardi and Co. of El Segundo, Calif., to study the problem of dust control in that industry and to seek practical remedies. Early in its research Menardi and Co. tackled the problem of high-temperature dust bag filters.

By experimenting with glass cloth to replace the wool and cotton bag filters generally in use, the company developed the process of silicone-impregnating glass cloth so that, while retaining the natural high heat-and-corrosive resistance of the original fabric, they produced a new fabric, smooth and silk-like in texture and durably flexible.

In tests of the new fabric, which the company calls Maco, the Air Polution Control Commission announced that it was 90% effective in the filtration of gases having in excess of 40% submicron particulate at temperatures up to 550 F.

The discovery of Maco practically doubles the heat range that can be effectively handled by bag filters, and materially reduces the amount of costly heat-control equipment required in the dust-control systems.

Moreover, maintenance of the bag-house operation is considerably simplified due to the ease with which the smooth, silk-textured fabric can be cleaned with less violent frequency of the shaking apparatus.

The company also points to reports that Maco is standing up well in practical operation. Some of the Maco-engineered filter bags have been in continual operation for from one to two years.

Bolt Extensometer

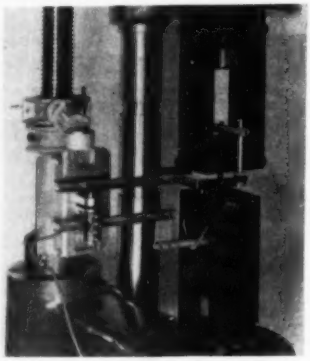
A new-type bolt extensometer designed for accurate tensional tests of bolts without the influence of shifting of grips or seating of the specimen, is announced by Baldwin-Lima-Hamilton Corp., Philadelphia, Pa. The new instrument was developed by International Harvester Co., Chicago, Ill., for testing the many sizes of threaded bolts required by the company. Slight refinements have been added by O. S. Peters Co., Washington, D. C., to provide unrestricted movement of extensometer arms.

Since the method of attaching extensometer arms to standard cylindrical specimens cannot be applied to threaded bolts, attachment has sometimes been made on the grips. Any shifting of the grips and seating of the specimen, therefore, distorts extensometer measurements.

To avoid the possibility of such errors the new extensometer has been designed to contact the center of the ends of the bolt, thus making direct and exact measurements of elongation. If the extensometer is left in position until actual fracture of the bolt, a complete load-elongation curve can be obtained, showing ultimate strength and overall elongation.

The two arms of the extensometer are essentially parallel at the start of a test. The lower contact is a long thumbscrew on the end of the lower arm which is held in position by a spring. The upper contact is a hardened point in a yoke that straddles the upper loading frame and has two knife-edge stirrups that support a yoke on the upper extensometer arm. Vertical arms holding the knife edges are adjustable to cover a range of bolt lengths.

Specimen holders consist of hardened tapered inserts fitted in boxlike holding fixtures. The upper insert has a clearance hole for the bolt and the lower one is threaded. Retainer plates keep the inserts and bolts from jumping out at fracture. The extensometer is designed to operate with loading frames of 50,000 lb capacity which accommodate bolts up to $^3/_4$ in. in size.



The extensometer is of the Microformer type, employing variable miniature transformers. In operation, changing deformation in the specimen actuates the movable core of the strain-follower Microformer, which changes its output and unbalances an electric circuit that includes a similar Microformer in a recorder. The resulting electric impulse is amplified to drive a servo motor, which moves the core of the recorder Microformer, thus rebalancing the electric circuit, and moves the recording mechanism in proportion to specimen deformation. The extensometer has magnifications of 12.5, 25, and 50 to 1.

A specially designed bracket supports the extensometer on an unstressed column of the testing machine.

Special Cathode-Ray Tubes

In addition to a complete line of RTMA-registered industrial-type cathode-ray tubes, the Allen B. Du Mont Laboratories, Inc., of Clifton, N. J., makes available a broad range of special cathode-ray tubes, for highly specialized applications whose requirements are beyond the capabilities of "standard" types.

Typical of these special types is the Type K1052, a 7-in. electrostatic tube containing five wholly independent electron-gun and deflection-electrode structures in a single glass envelope. Simple connection to all deflection electrodes of this tube is assured by an auxiliary ring-socket at the neck. The elec-

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PLUS an opportunity to work in a brand-new 700,000 square-foot plant at Bradley Field, Windsor Locks, Connecticut, now nearing completion . . . expanded research and development facilities . . . latest types of equipment.

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ONE OF THE FOUR DIVISIONS OF UNITED AIRCRAFT CORPORATION
EAST HARTFORD, CONN.

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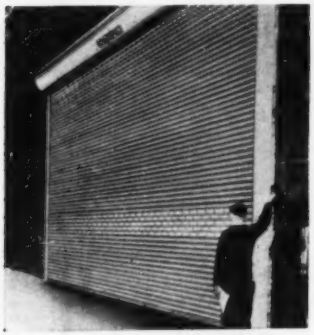
NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

tron gun and deflection structures are carefully shielded to minimize interaction between channels. Another tube is the Type K1101P, a 5-in. electrostatic tube designed for ultra-high-speed oscillography. Operated at accelerations up to 37,000 volts, the Type K1101P will present usable displays of frequencies as high as 1000 megacycles.

"Lookout" Steel Rolling Doors

Narrow, transparent panes of heavy-duty plastic are now available in one or more of the interlocking steel slats of the metal rolling doors manufactured by Kinnear Mfg. Co., Columbus, Ohio. This opening in the door closure is reported to offer new benefits applicable to many different sites where more interior light is required or vision to the outside is desirable.



The "window slats" at or near eye level permit anyone inside a building to see who is on the outside of the door before opening it. Also, they allow entry of daylight through the door when it is closed. This new feature is a supplement to basic construction principles for the interlocking slats originally conceived by Kinnear over a half-century ago.

DEFINITIONS OF OCCUPATIONAL SPECIALTIES IN ENGINEERING

A good book to consult for authorized definitions of approximately 500 occupational specialties in engineering.

Prepared by the ASME with the assistance of representatives of pertinent national engineering societies.

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Since 1910, Ric-wiL has been furnishing Sectional Conduit Systems for low cost, efficient protection of underground insulated pipe lines.

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CAST IRON CONDUIT—for installation under or near railroad tracks.

UNIVERSAL TILE CONDUIT—with half tile arch, trapezoidal side blocks, and concrete foundation.

Don't make the mistake of accepting inferior, poorly-designed and rank imitations of the original Ric-wil Sectional Systems. Make sure you specify "RIC-WIL"—preproved by thousands of installations—and know that you are getting the BEST.

RIC-WIL
INSULATED PIPING SYSTEMS
UNDERGROUND OR OVERHEAD

WRITE FOR LATEST CATALOG SECTION 480-4A.

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AGENTS IN PRINCIPAL CITIES
LEADERS IN INSULATED PIPING PROTECTION

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SECTIONAL CONDUIT SYSTEMS

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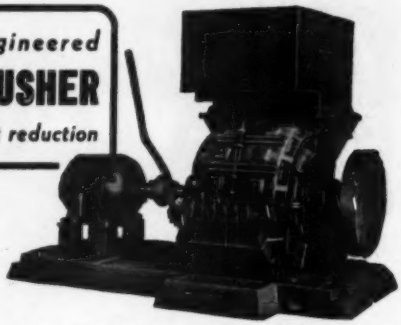
There's a job-engineered

AMERICAN CRUSHER

for uniform . . . low-cost reduction



. . of COAL, CLAYS, CHEMICALS, STONE, METAL TURNINGS, WOOD, DRY ICE, FOOD—hundreds of products of every description.

Metal Turnings Crusher—reduces long, curly turnings of steel, alloys, brass, aluminum, etc., to uniform chips for highest cutting oil recovery . . . increased scrap value.

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"AC" Ring Mill—with exclusive shredder rings—for uniform, high tonnage reduction. 500 TPH. "24 Series" ring or hammer crushers offer capacities to 50 TPH. . . . "30 Series" Hammermills to 100 TPH.

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One of six carloads of Heat Exchangers, Coolers, Condensers and Reboilers designed and fabricated by the Heat Transfer Division of DOWNINGTOWN for a chemical plant. Materials used consist mainly of Type 304 Stainless Steel . . . construction meets requirements of the ASME Code.

DOWNINGTOWN solicits your inquiry for heavy duty shell and tube equipment fabricated of Aluminum, Inconel, Nickel, Phosphor Bronze, Copper, Silicon Bronze and various grades of Carbon Steel. Some of these are welded by the Inert-Gas-Metal-Arc method. DOWNINGTOWN is experienced in building equipment with Blastellic, Finned Tube and Impregnated Graphite.

Design and construction meet requirements of ASME Code or other agency specified by customer. Equipment of our design is sold on a guaranteed performance basis or we will fabricate to customer's drawings. Modern facilities available for radiographing where required. Remember: *"Your Needs are Our Specialty!"*

Write on your letterhead for DOWNINGTOWN literature on shell and tube heat exchangers.

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STEEL + ALLOY PLATE FABRICATION
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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Resistance Thermometers

A new line of resistance thermometers designed for accurate indication and control of temperatures ranging from minus 100 F to plus 300 F has been announced by the General Electric Company's Meter and Instrument Department.

The new instruments, applicable in a wide variety of industrial processes, are available in three basic types: the HP-11 resistance-thermometer indicator; the HP-13 two-position controller or protector; and the HP-14 three-position controller. Each type is designed for either flush or surface mounting.

All the thermometers use the same basic mechanism, a crossed-coil moving element and a high-strength $3^1/_2$-lb alnico V magnet, designed for hard usage and reliable operation. The entire mechanism is enclosed in a dust-tight, moisture-resistant case-and-cover assembly that permits its use in moist or contaminated atmospheres.

Typical examples of equipment with which the thermometers are used include enamel baking ovens, vacuum dryers, low-temperature extruding machines, quenching tanks, distillation kettles, rubber vulcanization apparatus, and aging ovens. The devices also find use in the food-processing, air-conditioning, and refrigeration industries.

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Under the sign of the cancer sword the American Cancer Society seeks to save lives by spreading vital facts to you, your neighbors, and your physicians . . . by supporting research . . . by providing improved services for cancer patients.

Only under the sign of this sword is there a three-fold, national attack on cancer. Cancer Strikes One in Five. Your Dollars Will Strike Back.

Mail Your Gift to "Cancer" Care of Your Local Postoffice

AMERICAN CANCER SOCIETY

Rollpins

Hundreds of thousands of minute plated-steel Rollpins have been purchased to date by the Ritepoint Co., St. Louis, Mo., manufacturers of Ritepoint Liters, the lighter with visible fuel supply, as axles for the spark wheels in their cigarette lighters. Designed to fit a hole with diameter of only $^{3}/_{32}$ in., the high-pressure, shakeproof, pressed-fit metal fastener is one of the three smallest Rollpins made by the Elastic Stop Nut Corp. of America of Union, N. J. Permitting a simpler and faster assembly than a

rivet or screw-type fastener, the flush-mounted Rollpin replaces a previously used solid brass pin with chrome finish. Because of its self-retaining characteristics, the pin is held securely in place without any supplementary fastening device whatsoever. The illustration shows the tiny Rollpin in place in the spark wheel, compared with a $^{1}/_{4}$-in. Rollpin. The Rollpin is produced with diameters ranging from $^{1}/_{16}$ through $^{1}/_{2}$ in.

Business Notes

Allegheny Purchases Industrial Site

Allegheny Ludlum Steel Corp. has purchased the 160-acre industrial site known as "Murphy's Flats" on the west bank of the Allegheny River three miles north of Freeport, Pa.

The site, situated about 12 miles from the company's Brackenridge plant and also easily available to its West Leechburg plant, was bought for future expansion of the company in the Pittsburgh District. The purchase, it was announced, has been made with a view to providing for future expansion and was deemed desirable since company properties at Brackenridge and West Leechburg are almost completely occupied.

Robertshaw Enters Electronics Field

Fulton Sylphon Div., Robertshaw-Fulton Controls Co., Greensburg, Pa., has taken the first steps in its program of entering the Industrial Electronic Measurement and Controls Field, through the acquisition of the Fielden Instrument Corp. of Philadelphia. For the present, Fielden Instrument Corp. will operate as a wholly-owned subsidiary of Robertshaw-Fulton Controls Co.

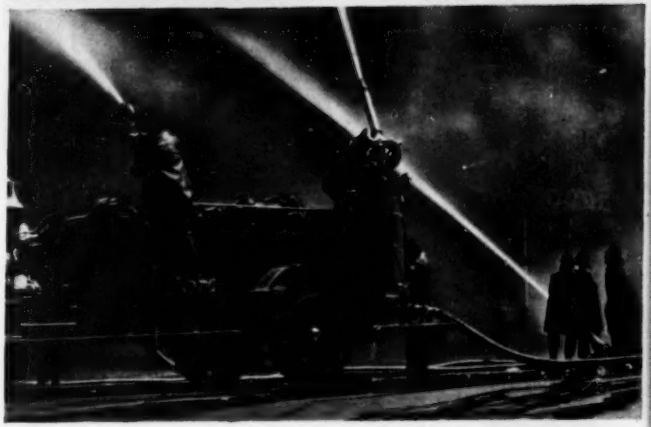
Consolidated Western Steel Corp. and U. S. Steel Co. Merge

On Dec. 31, 1951, Consolidated Western Steel Co., together with 17 other operating subsidiaries of United States Steel Corp., ceased doing business as a separate company and was merged into United States Steel Co., which is also a subsidiary of United States Steel Corp. The plants and business of this company will continue operations as the "Consolidated Western Steel Div., United States Steel Co."

Fenwal Appoints New Washington Representative

Fenwal Inc., of Ashland, Mass., manufacturer of the Thermoswitch thermostat for precision temperature control and detection, announces the appointment of J. C. McDougall Co., Seattle, Wash., as its new sales representative in most of the State of Washington. The McDougall Co. will provide sales and engineering services for Fenwal Thermoswitch units and Detect-A-Fire fire detectors.

when water pressure means the most



City officials, municipal and industrial engineers shoulder a tremendous responsibility in the maintenance of water pipe lines. They know that pressure failure due to leakage or tuberculation can often have disastrous results.

Today, the neglect of water lines—however old—is uneconomic. The Centriline process of centrifugally applying cement-mortar lining to pipe lines *in place* virtually makes new pipes out of old at a fraction of the cost. Centrilining, not only prevents tuberculation and leakage, but totally eliminates corrosion to the inner walls. Pumping costs are lower, maintenance reduced and the saving over new pipe lines often amounts to many thousands of dollars.

Write today for your free copy of our new bulletin describing the Centriline process.

CEMENT-MORTAR LININGS FOR PIPE IN PLACE...

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Housed in this 14-story building at Consolidated Edison's Hudson Ave. Plant in Brooklyn, N. Y.

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Internal Gear and Bearing Vertical Type. 75 HP. 1180 RPM. Handles 300 GPM at 210 PSI, 10,000 SSU.

LEFT—being readied for shipment: one of the six Sier-Bath Screw Pumps selected by Consolidated Edison for vital burner service in the Hudson Avenue Plant installation. As the pumps had to be installed completely *submerged* (making repairs and servicing difficult and costly), prime factors in their choice were *dependability* and *low maintenance needs*. The following features give these qualities to Sier-Bath Screw Pumps:

- **No Metallic Contact Between Rotors**—sustains high volumetric efficiency.
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- **Low Pressure on Stuffing Boxes**—reduces leakage, adds to packing life.
- **Long, Trouble-Free Life**—husky shafts, rotors—high load capacity bearings, deep stuffing boxes.
- **Self Priming • Pulseless Discharge • Direct-connected up to 1800 RPM.**

Models for 1-700 GPM, discharge 1000 PSI for viscous liquids, 500 PSI for water. Available in horizontal or vertical construction, corrosion resistant alloys. Special bodies, stuffing boxes and bearings for high temperature applications.

WRITE FOR BULLETIN

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BUSINESS NOTES
LATEST CATALOGS

Physicists Research Co. Changes Name

Physicists Research Co., manufacturer of the Profilometer, has changed its name to Micrometrical Mfg. Co. Management, personnel, facilities, and products remain unchanged.

As indicated by the former name, this company was established to handle research and development projects for industry. In the course of these activities, the company developed various instruments, which they began to build and sell.

At the same time, the mailing address and reception room have been changed to a company-occupied building at 345 S. Main St., Ann Arbor, Mich.

Concurrently, the company's development operations have moved to a new building and are now operated as Micrometrical Development Corp. at 2821 S. State St., Ann Arbor, Mich. The Development Corporation builds and sells only those instruments that are in process of development, and is staffed by the former Physicists Research Co. development group. All manufacturing, repair, and sales work on the Profilometer is handled by Micrometrical Mfg. Co.

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LATEST CATALOGS

Westinghouse Union City Plant Begins Production

Limited production and the beginning of gradual employment at Westinghouse Electric Corporation's new Small Motor Division Plant at Union City, Ind., began on February 11.

A scarcity of critical materials and the necessity of training each new employee individually has advanced the opening date somewhat.

Located on 35 acres of ground, the plant is of modern design and construction, is fluorescent-lighted throughout, has high windows for maximum natural lighting, and includes air-conditioned offices and a complete medical department.

It will use modern, straight-line production methods. Many miles of overhead conveyer systems will carry the work in progress to its various destinations. The plant is so arranged that raw materials will be delivered at one end, they will be processed and assembled, and the finished motors will be shipped out the other end.

Allegheny Changes Division Name

Allegheny Ludlum Steel Corp. has changed the name of its sintered carbide production and sales units from Carbide Alloys Div. to Carmet Div. Carmet is the trade name under which products of the division are marketed.

Carmet Div. is a principal producer of tungsten and other sintered carbide alloys, having pioneered their use in laminations and other dies for tips for such applications as mining bits. The division has been located at Ferndale, Mich., on the outskirts of Detroit, since it was acquired by the company in October, 1943. The plant has expanded rapidly since its acquisition and is now undergoing expansion on a large scale.

Fowler Co. to Represent American Flexible Coupling Co.

The Charles A. Fowler Co., San Francisco, Calif., has been named by Zurn Western Services, Inc., as Northern California sales representatives for the sale of the new crown flanked Amerigear flexible couplings, as well as the American type flexible coupling.

De Laval Forms Subsidiary

The De Laval Steam Turbine Co., Trenton, N. J., has announced the formation of a subsidiary corporation, the De Laval Turbine Pacific Co. Headquarters for the company will be in the new building at Main and Folsom Streets, San Francisco, Calif.

Branch Sales Offices are located in Los Angeles, Calif., and Seattle, Wash.

The San Francisco headquarters building includes warehouse facilities for standardized De Laval products, including centrifugal and IMO Rotary pumps, speed reducers; couplings and spare parts, together with shop facilities for local handling of repair and service orders.

In addition to the complete line of De Laval turbines, pumps, gears, blowers, speed reducers, couplings, and IMO Rotary pumps, the new company will also act as authorized representatives for Waukesha industrial engines, Kellogg-American air compressors, and Diehl Electric motors and other allied industrial lines.

In chip recovery only through engineering ...can efficiency be achieved

Industrial mobilization demands maximum use of all materials in short supply—metals particularly. Unit production costs, as well as economy of over-all operation, are directly dependent on strict...

...conservation of critical materials

The operating economies made possible by a Gifford-Wood engineered chip recovery system are evident in the higher sale value of clean scrap, the re-use value of soluble and cutting oils.

To the metal-working industry this means that a complete G-W salvage installation—crushers, conveyors, extractors, bucket-type elevators, loading bins—assures top efficiency. Centralized responsibility for the full installation designed to your requirements means saving in time and money. Sound business judgement dictates...

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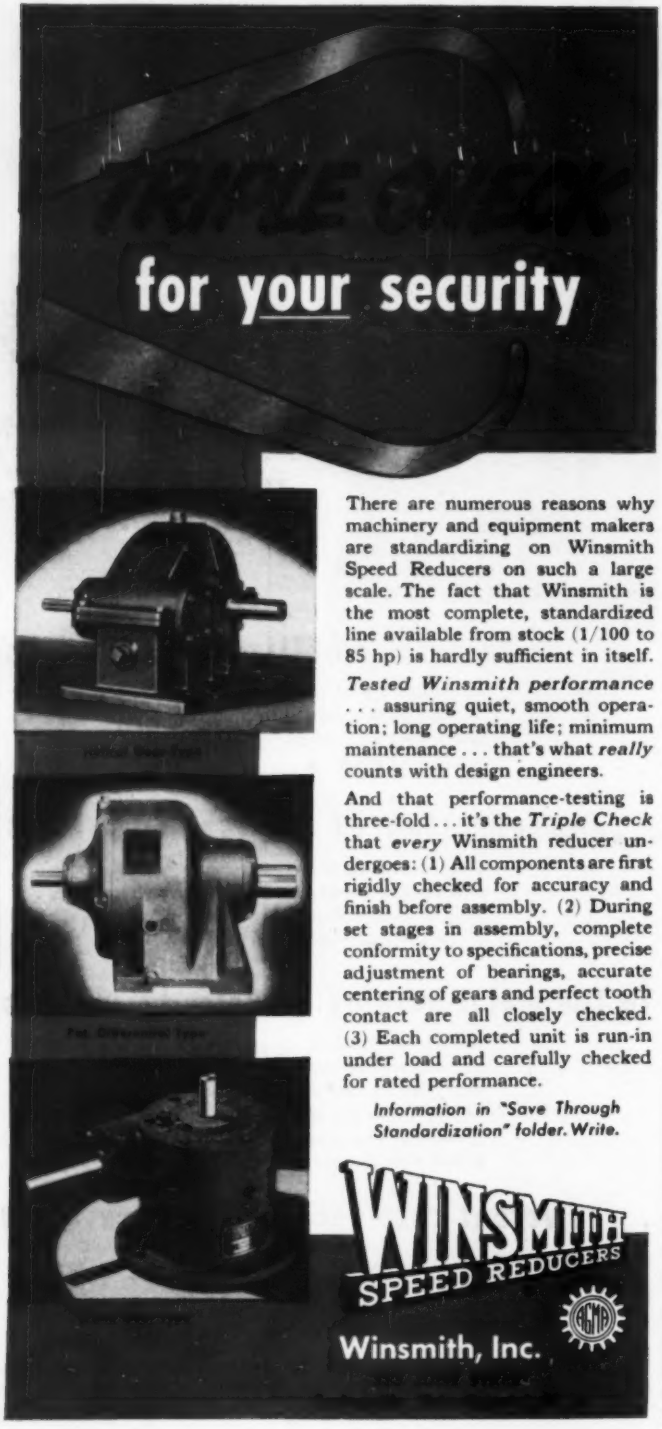
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There are numerous reasons why machinery and equipment makers are standardizing on Winsmith Speed Reducers on such a large scale. The fact that Winsmith is the most complete, standardized line available from stock (1/100 to 85 hp) is hardly sufficient in itself.
Tested Winsmith performance . . . assuring quiet, smooth operation; long operating life; minimum maintenance . . . that's what really counts with design engineers.
And that performance-testing is three-fold . . . it's the Triple Check that every Winsmith reducer undergoes: (1) All components are first rigidly checked for accuracy and finish before assembly. (2) During set stages in assembly, complete conformity to specifications, precise adjustment of bearings, accurate centering of gears and perfect tooth contact are all closely checked. (3) Each completed unit is run-in under load and carefully checked for rated performance.
Information in "Save Through Standardization" folder. Write.
WINSMITH
SPEED REDUCERS
Winsmith, Inc.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Kellogg Awarded $75 Million Contract for AEC Process Piping

The complexity of the chemical processing behind an atomic bomb was further indicated by the announcement that The M. W. Kellogg Co., New York, N.Y., has been awarded a $75 million contract for the field-fabrication and erection of the process and auxiliary piping and related equipment in the two major gaseous diffusion units now well underway at Paducah, Ky.

The processing sections of the plant are considered the ultimate in complexity, according to Kellogg, and are designed for resistance to corrosion as well as low-temperature operation. These Paducah plants are similar to the K-25 installation at Oak Ridge, which Kellogg, through a specially formed subsidiary (Kellex Corp.), engineered during World War II. They separate the fissionable isotope, U-235, from uranium hexafluoride, a gasified compound including both the normal uranium and its "explosive" isotope.

To meet the emergency completion schedule, Kellogg is training welders in a special school set up at Paducah. These men are being put on the job as soon as they pass Kellogg requirements. When completed, the entire project will take up about 7500 acres, of which about 20% will be deeded to Tennessee Valley Authority for an $88 million steam power plant some five miles from the plant. This, and an equally large power plant constructed by private industry, will supply a constant power load of about 1 million kw.

Gasoline From Coal Plants Not Far Off

Chemicals are the key that will unlock the door to establishment of an American synthetic liquid fuels industry, and that door will be unlocked sooner than most people think, the Research Manager of Koppers Company, Inc., declared recently.

Dr. G. F. D'Alelio announced that Koppers is backing that belief by forming a co-ordinated Fuels Processing Section of its Research Department. This section, he said, is designed to accelerate the pace of Koppers research not only in coal carbonization in which it has been engaged since 1907, but to probe more deeply the gasification and hydrogenation of coal, with particular emphasis on the chemicals which may be produced.

G.E. Forms Silicone Products Dept.

The formation of a new General Electric Co. Chemical Div. product department to be known as the Silicone Products Dept. has been announced.

With the formation of the Silicone Products Dept., having headquarters in Waterford, N. Y., the G-E Chemical Div. is now made up of four product departments, the other three being Plastics, Chemical Materials, and Laminated and Insulating Products.

Formerly included as products manufactured by the Chemical Materials Dept., the formation of a separate department to produce silicones was made desirable by the rapidly expanding silicone business.

For Consulting Engineers Turn to Page 134

BALL BUSHING

The BALL BEARING for your

LINEAR MOTIONS

Sliding linear motions are nearly always troublesome. Thousands of progressive engineers have solved this problem by application of the Precision *Series A* or Low-Cost *Series B* BALL BUSHINGS.

Alert designers can now make tremendous improvements in their products by using BALL BUSHINGS on *guide rods, reciprocating shafts, push-pull actions,* or for support of *any mechanism that is moved or shifted in a straight line.*

Improve your product. Up-date your design and performance with BALL BUSHINGS!

Now manufactured for ¼", ⅜", ½", ¾", 1", 1½" and 2½" shaft diameters.

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ELIMINATES BINDING AND CHATTER
SOLVES SLIDING LUBRICATION PROBLEMS
LONG LIFE • LASTING ALIGNMENT

Write for descriptive literature and the name of our representative in your city.

Progressive Manufacturers Use Ball Bushings —A Major Improvement at a Minor Cost

THOMSON INDUSTRIES, INC.

Dept. C MANHASSET, N.Y.

Also manufacturers of NYLIMED Bearings — DuPont NYLON within a metal sleeve—for rotation and reciprocation.

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NEW EQUIPMENT
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B & W Tube to Make Special Tank Tubing

A contract designed to make available added facilities for the manufacture of a special type of tubing needed to speed America's combat tank production program has been negotiated between The Babcock & Wilcox Tube Co. of Beaver Falls, Pa., and the Ordnance Corps, Department of the Army, the company has announced. The special tubing will be used in making tank treads.

The announcement says the contract calls for installation of just under a million dollars in new equipment, in addition to that already existing for this purpose, in the company's plant. The additional facilities will be leased from the government by the Tube Company and will be housed in buildings under construction at the plant in Beaver Falls, Pa.

Tank tread pin tubing, according to the company, is seamless, small diameter, heavy wall, cold finish alloy tubing. It is used in the assembly of the tank track for many of the tanks and other types of mobile equipment using tracks produced under jurisdiction of the Army Ordnance Corps through the Ordnance Tank-Automotive Center in Detroit and other areas.

Latest Catalogs

Jet Pumps

A bulletin, No. 512, on jet pumps is available from Penberthy Injector Co., Detroit, Mich. The extremely diversified application of Penberthy jet pumps is highlighted.

Friction-Free Surfaces

A new folder released by Van Der Horst Corp. of America, Los Angeles, Calif., explains the use of Van Der Horst Porus-Krome in cylinders and the application of engineered hard chromium on other wearing surfaces to reduce friction and wear.

Industrial Instruments

Catalog No. 5000, consisting of 28-pages, describes the principal instruments, control devices, and related components manufactured by the Industrial Div. of Minneapolis-Honeywell Regulator Co., Philadelphia, Pa. Specifications of approximately 100 measuring and control instruments, and valves are outlined. Included are several new designs including the differential controller and Tel-O-Set controller family.

Safety Manual

A new 60-page manual, No. 25E7524, published by Allis-Chalmers West Allis Works Safety Council contains a description of general standards, general rules for overhead work and excavations, safety rules for millwright and machine repair work, for electrical maintenance, and for plumbing and steamfitting, along with rules for outside contractors. These standard operating procedures are the result of regulations or rules developed over a period of years at Allis-Chalmers.

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SPECIFY GRAPHALLOY WITH CONFIDENCE

SELF-LUBRICATING • EXTREMELY DURABLE • CONSTANT CO-EFFICIENT OF FRICTION • OPERATES DRY — OR *SUBMERGED IN WATER, GASOLINE OR CORROSIVE LIQUIDS* • APPLICABLE OVER A WIDE TEMPERATURE RANGE — *even where oil solidifies or carbonizes* • EXCELLENT AS A CURRENT-CARRYING BEARING.

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There are excellent opportunities, right now, for experienced and junior engineers for aircraft

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also for servo-mechanism and electronics designers and analysts and for physicists and mathematicians with advanced degrees.

Boeing offers you work on such vital projects as the security-shrouded B-52, on the six-jet B-47, and on guided missiles and other revolutionary programs.

Openings are available at both Seattle and Wichita. Your choice of location—Pacific Northwest or the Midwest. You'll enjoy a good salary that grows with you, and Boeing provides a generous moving and travel expense allowance.

You'll be proud to say, "I'm a *Boeing* engineer!"

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Boeing Airplane Company, Seattle 14, Wash.

Engineering opportunities at Boeing interest me. Please send me further information.

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Get Acquainted Booklet

A new booklet is available that tells about the H. K. Porter Co., Inc., of Philadelphia, Pa., its Divisions and Subsidiaries, products manufactured, and lists key personnel.

Speed Reducers

A pocket-size catalog of Speed Reducers and Right Angle Gear Motors is announced for distribution by Abart Gear & Machine Co., Chicago, Ill. The 96-page book gives complete engineering data on how to select the proper speed reducer to fit requirements, including horsepower ratings, ratios, and installation graphs.

Electric Air Heaters

Portable and built-in electric air heaters used in every industry and business are described in a new four-page folder, No. F-1530 available from Edwin L. Wiegand Co., Pittsburgh, Pa. Convection, blower, duct, and radiant types available for immediate shipment are shown along with suitable automatic controls. Application photographs illustrate factory and office uses. The units, which provide safe, clean, dependable heat for continuous or stand-by needs, are standard stock. Special sizes and ratings can be custom-made to suit requirements.

Openly Ventilated Dry-Type Transformers

The proposed AIEE guide for the use of openly ventilated dry-type transformers with Class B insulation is contained in a new 8-page bulletin, No. 61X7088B, released by Allis-Chalmers Mfg. Co., Milwaukee, Wis. The guide gives general recommendations on installation, inspection, storage, maintenance, and operation. It includes distribution and power dry-type transformers in ratings above 50 kva and above 600 volts, cooled by natural draft or forced draft.

Oscillographs

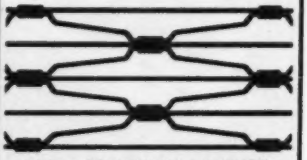
A new bulletin, No. R 1052 on direct recording oscillographs and associated amplifiers is available from Rahm Instruments Inc., New York, N.Y. The Rahm RO direct recorder and OB amplifiers are newly engineered instruments designed to provide the optimum in linearity and frequency response characteristics while maintaining versatility of application and structural ruggedness. The RO recorders and OB amplifiers offer a heretofore unobtainable choice of d-c and a-c/d-c recording-amplifying systems making possible a selection of low or high gain units for a wide range of input levels.

Refractories

A new 12-page illustrated brochure just published by Johns-Manville, New York, N. Y., entitled, "Hydraulic Setting Refractories," presents the five different J-M Firecrete products for casting special refractory shapes and the three J-M Blazecrete products for gunning and slap troweling applications. These are hydraulic-setting refractories for services through 3000 F. The brochure contains suggestions for solving maintenance problems as well as recommendations for casting shapes and linings. Photographs show typical uses and illustrate handling methods. The text includes descriptive information and tables giving pertinent data.

GRATING-FLOORING
and
STAIR TREADS
ALL TYPES — ALL SIZES

RECTANGULAR MESH — ABOVE
or
RETICULINE MESH — BELOW



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SELF-CLEANING • SELF-DRAINING
ADMITS AIR AND LIGHT
STRONG • FIREPROOF • DURABLE
ECONOMICAL

WRITE FOR CATALOG AND ESTIMATE

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LONG ISLAND CITY 1, NEW YORK
Western Division: 1010 Tenth Street
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MORE IRON AND STEEL SCRAP . . . OF ALL KINDS!

Steel mills and foundries need more scrap.

Not just "production" scrap from metal-fabricating plants . . . but also all sorts of *idle* iron and steel—from all types of plants.

Search *your* plant for this idle metal . . . work with your local scrap dealer to increase supplies of badly-needed iron and steel scrap.

What to look for . . .

obsolete machines, tools and equipment, no-longer-used jigs and fixtures, worn-out or broken chains, wheels, pulleys, gears, pipe, tanks, drums and abandoned metal structures. Non-ferrous is needed, too!

Keep Informed

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Welding

A new 20-page illustrated booklet, "Improved Design for Welding," has been announced by Linde Air Products Co., a Division of Union Carbide and Carbon Corp., New York, N. Y. The booklet describes the economies of good welding design as compared to haphazard design methods. Included in the booklet are reprints of welding papers and a summary of standard welding symbols abstracted from the "American Welding Society Summary of Standard Welding Symbols."

Centrifugal Pump Instructions

An instruction booklet, No. 08X7613, covering the installation, operation, and repair of single-stage, double-suction centrifugal pumps has been released by Allis-Chalmers Mfg. Co., Milwaukee, Wis. The booklet recommends that a regular inspection be followed and includes a maintenance timetable which is based on continuous pump operation and which serves as a reliable pattern for all practical purposes. The booklet also carries a quick reference guide which lists 40 possible causes of trouble in pump operation and their cures.

Stainless Valves and Fittings

The Cooper Alloy Foundry Co., Hillside, N. J., announces the publication and availability of a new periodical, "Valve Topics," edited for those who design, specify, use, or purchase stainless-steel valves and fittings. "Valve Topics" will be devoted exclusively to the task of providing information about the uses and abuses of stainless-steel valves; application stories depicting how Cooper Alloy valves and fittings serve in industry; and special features such as: Items of Interest, a review of current literature available; Questions and Answers, selected at random from sales engineering files; and Technical Topics, a column devoted to a detailed examination of specific valve problems.

Flexible Shafting

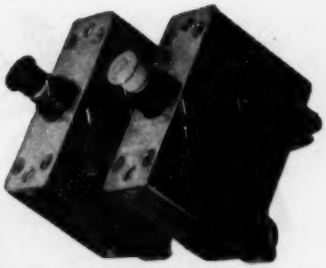
The F.W. Stewart Mfg. Corp. of Chicago, Ill., has issued a 64-page book on their flexible shafting. It shows with graphic illustrations many applications in a great variety of industries. The advantage of flexible shafting and method of application is fully described. There are also illustrated many types of end fittings, casings, adapters, and shaft combinations that apply to the variety of standard sizes and types of shafts available. Over 400 illustrations help the engineer to solve his problems on remote control by the use of flexible shafts.

Arc-Furnace Electrical Equipment

new 20-page booklet, No. B-4695, describing electrical equipment for arc furnaces is available from Westinghouse Electric Corp., Pittsburgh, Pa. The booklet discusses application of electrical equipment to both direct and submerged arc furnaces, for applications in steel mills, chemical plants, foundries, and nonferrous metal refineries. Electrical equipment described, in addition to Optimelt arc furnace control, includes circuit breakers, transformers, furnace regulators, and control panels.

A Bit of

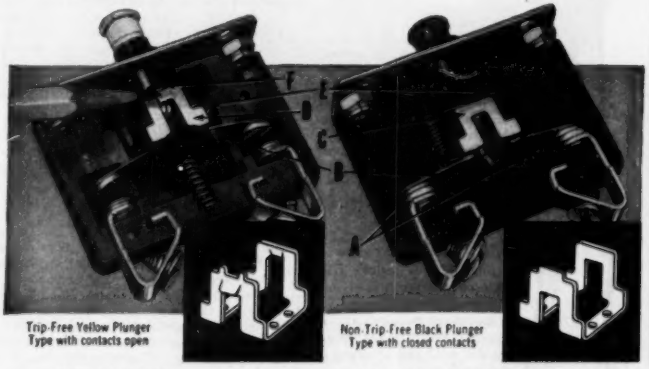
CHACE BIMETAL MAKES THE BIG DIFFERENCE IN THESE M-P BREAKERS



Product of:
Mechanical Products, Inc.
Jackson, Mich.

The only external difference in these miniature breakers manufactured by Mechanical Products, Incorporated, is that one is black and one olive drab. But the BIG difference is that the OD is Trip Free—i.e. cannot be maintained closed against serious overloads—while the black may be forced to contact. This factor is of extreme importance in blowers, heaters and other devices requiring positive protection but with limits on weight and space. The M-P breakers weigh 2 ounces.

Here's how they work:



Trip-Free Yellow Plunger
Type with contacts open

Non-Trip-Free Black Plunger
Type with closed contacts

When the plunger is pressed in, the element assemblies latch in the position as in the right hand view, closing contacts "A". The current then passes through blades "B" and thermostatic bimetal elements "C" and "D". Resistance of the elements causes them to heat up under overload currents. The upper ends of the U-shaped elements spread apart, the springs "E" trip the breaker and the plunger retracts bringing the element-blade assemblies with it as in the left hand view. The non-trip free (black) plunger (right) may be held in, making contact whether the condition is corrected or not. The trip-free (yellow) plunger, however, works freely in and out of the element, the movement being actuated by the small stop "F" which impinges normally against the top of the element. When the element opens up, the stop passes under and springs "E" move the element-blade assembly to open position. Contact cannot be forced. When the bimetal cools, the element closes up, the sloping boss (under pencil point) permits the stop to slide under the element again as the plunger is pulled out to reset, ready for action.

Chace Applications Engineers worked closely with Mechanical Products in the development of this intricate breaker and consultation is readily available should you have a problem in temperature-actuated devices. Chace Thermostatic Bimetal is available in strips, random coils or in complete elements. Write for our 64-page reference on thermostatic bimetal selection and element design.

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.

MORE THAN A "COOLANT" IS NEEDED

"COOLANT" is a misnomer as applied to *cutting fluids*. You won't get far with just a coolant. The fluid used for metal cutting must have multiple characteristics in order to provide the desired finish and tool life at the required production rate:

- **Cooling Action**—necessary to carry away the heat generated by machining, but only part of the function.
- **Lubricity**—to reduce friction between the tool and the work piece.
- **Anti-Weld Properties** — to prevent build-up of metal on the tool and scuffing of the work piece.

These factors and others are all inter-related. Over-simplification of the subject and the cutting fluid can lead to trouble.

Let a Stuart sales-engineer show you what can be accomplished with the *right* cutting fluid.

Ask for Bulletins

Get the Facts
Visit the
STUART BOOTH
No. 1823
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ASTE SHOW
Chicago, Mar. 17-21

D. A. Stuart Oil Co.

2741 S. Troy Street, Chicago 23, Ill.

Time-Tested

Cutting Fluids and Lubricants

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

General-Purpose Pumps

Construction details on grease-lubricated pedestal-mounted general-purpose pumps (Type SSB) are given in a new bulletin, No. 52B6351B, released by Allis-Chalmers Mfg. Co., Milwaukee, Wis. The pumps, available in capacities to 2500 gpm at heads to 550 ft, can be had with stuffing box or mechanical seal, direct coupling or V-belt drive and in a choice of materials. One of the many combinations of materials and seals possible with this pump will handle almost any liquid at temperatures to 250 F.

Temperature Controls

A new 52-page catalog, No. 400, on Thermoswitch temperature controls has just been published by Fenwal Inc., Ashland, Mass. The three-color catalog describes the design, operating characteristics, and installation of each of the 10 variations on the basic Fenwal thermostatic device. A special section concerning the selection and application of the Thermoswitch discusses such subjects as operating differential, sensitivity, temperature variation, lag and overshoot, characteristics of heat sources, frequency of switching, and installation in solids, liquids, and gases.

Flue Gas Analyzer

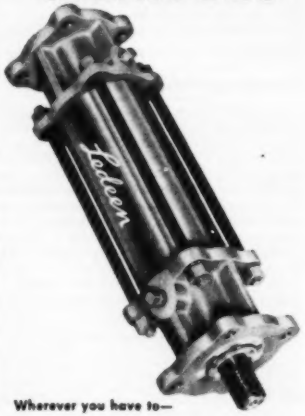
An Instrumentation Data Sheet, No. 10.15-3a, available from Minneapolis-Honeywell Regulator Co., Philadelphia, Pa., describes the Davis indicating and recording flue gas analyzer which utilizes a Davis thermal conductivity gas analyzer in combination with a Brown ElectroniK recorder. The combined apparatus provides continuous recorded combustion analysis. The data sheet describes the equipment and explains how it is used for combustion control analysis and describes the operation and construction of the apparatus. Photographic illustrations and schematic diagrams facilitate the explanation of the device and are included in the four-page data sheet.

Cooling and Heating Coils

Latest developments in extended surface cooling coils, for use with direct expansion refrigerants and chilled water in air-conditioning or process applications, are summarized in a revised 72-page bulletin, "Cooling Coils," DS-365, published by The Trane Co., La Crosse, Wis. Added to the bulletin is a completely new coil, Type S, for use where the quantity of water is restricted and a redesigned coil, Type OS, that can be completely drained where danger of freezing exists. Both coils can be used for either right or lefthand connections, simplifying installation. Special consideration is given to coils designed for such industrial applications as gas cooling, butane vaporizing, transformer oil cooling, generator cooling, and condensing of gaseous refrigerants.

Another bulletin, No. DS-385, covers Trane's complete line of steam and hot-water coils for a wide range of applications, in both standard and nonfreeze types. The catalog outlines capacities, selection, performance, installation, and dimension data on all Trane heating coils. Standard coils have a solderless bond, formed by mechanical expansion of seamless copper tubing into aluminum flat plate fins. This method of construction contributes to the coils' high heat-transfer efficiency and durability.

REPLACE COMPLICATED MECHANISMS WITH Ledeen CYLINDERS



Wherever you have to—

PUSH or PULL
LIFT or LOWER
PRESS or SQUEEZE
TILT or TURN
OPEN or CLOSE

Ledeen cylinders provide positive, dependable power and pressure in straight line motion. Designed for air, oil, or water operation, they are uniform in design and construction, affording a wide number of varieties and adaptations. Ledeen cylinders are easy to install, occupy minimum space, and are built for long, economical service.

Standard Ledeen cylinders and mountings are available from distributors' stocks in major cities. Special cylinders if required. J.I.C., of course.

Ledeen Cylinders are GOOD Cylinders

Write for Bulletin 500

Ledeen Mfg. Co.
1600 San Pedro
Los Angeles 15, Cal.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Gears

A 4-page illustrated bulletin entitled "Power-Thrifty Products by Phillie Gear" is offered by Philadelphia Gear Works, Philadelphia, Pa. It shows their line of gears, speed reducers, flexible couplings, and Limi-Torque valve controls. Types and size ranges are given.

Fuel-Oil Heaters

Catalog No. 714 is announced as available from Hauck Mfg. Co., Brooklyn, N.Y. It explains the advantages of Oil Tank Suction Heaters for heating heavy grades of fuel oil to pumping temperatures, and also on preheaters which raise the oil from pumping temperature to the higher temperature required at the burners for good atomization, combustion, and control.

Production Presses

American Steel Foundries, Elmes Engineering Div., Cincinnati, Ohio, offer an illustrated bulletin, No. 1036, which gives complete description and specifications on low-cost Elmes Hydrolairs—small, fast, power-operated production presses that have neither motors nor pumps. Power is taken entirely from the shop air line.

Safety and Relief Valves

A new O.E.M. catalog folder, available from Kunkle Valve Co., Fort Wayne, Ind., illustrates air, gas, steam, and liquid relief valves for original equipment application. Listings of ASME, N.B., Mass., Canadian, and Government-Approved valves are included with service recommendations. New Kunkle designs and valves formerly made by Star Brass Mfg. Co. of Boston, but now manufactured by Kunkle, are also shown.

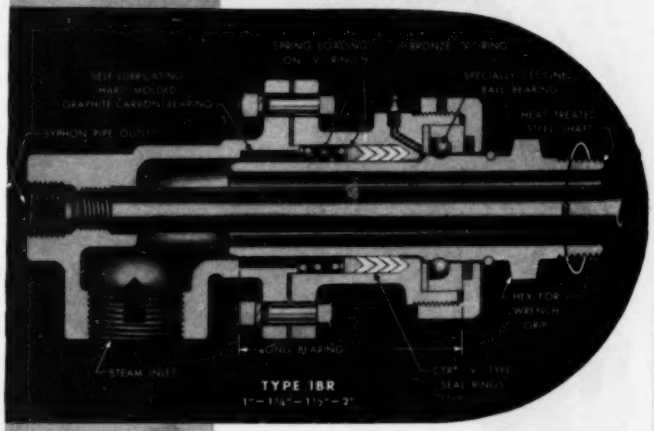
TEFC Motors

Construction features and details of totally enclosed, fan-cooled motors with tube-type, air-to-air heat exchangers in ratings from 40 hp at 600 rpm through 800 hp at 3600 rpm are described in a new bulletin, No. 51B7149B, available from Allis-Chalmers Mfg. Co., Milwaukee, Wis. The bulletin points out that the motors are available in standard and explosionproof designs. The former are for applications without explosion hazards but requiring protection of the windings from dust, dirt, acid fumes, etc. Explosionproof machines are available, with Underwriters' labels, for atmospheres with flammable gases presenting no greater hazard than high test gasoline vapor and air mixture, and for atmospheres with such combustible dust as carbon black, coal, coke, or grain.

Power Plant Packings

Johns-Manville of New York, N.Y. has issued a 6-page folder entitled, "Packings for the Power Plant." Designed as a quick reference aid, one of the features of this compact guide is a flow sheet of a rudimentary industrial power plant with each unit keyed to the proper packings and gaskets. These, in turn, are illustrated with close-up photographs followed by short paragraphs giving construction information, sizes, and similar pertinent data. In addition, the packings and gaskets are grouped on the pages according to the applications and services for which they are recommended. Also, where packings have more than one application, cross-references are supplied in the text.

BARCO Revolving JOINTS



Syphon Style—TYPE IBR. Built for 450°F., steam service to 150 psi, and up to 500 RPM. Hydraulic service to 200 psi, 750 RPM. Higher pressure and speeds under certain conditions.

Single Flow Style—TYPE IBRSA. Similar to Type IBR. Sizes 1" and larger have 2-piece flange connected body.

Up to 50% power savings!

PRODUCT DESIGNERS and plant engineers throughout the country have been quick to recognize the ADVANTAGES offered by Barco's new *improved* Type IBR Revolving Joint for service on drum type dryers, coating rolls, calenders, mixing drums, clutches, chucks, chill rolls, sanforizers, and other rotating machinery:

- Free-Floating, Low Torque Installations.
- Up to 50% Power Savings.
- Better Temperature Control where steam is used for heating rolls.
- Low Maintenance; No Adjusting.
- Ability to Withstand Vibration and Hard Usage.
- All Ports Easily Accessible.

Send for a copy of BULLETIN 300

Barco builds a complete line of revolving joints for steam, water, air, oil, gas, and hydraulic service. Sizes from ¼" to 5". Pressures to 250 psi, steam, or 1000 psi, hydraulic. Speeds to 2500 rpm. *Barco Engineers are at your service; ask for recommendations.* BARCO MANUFACTURING CO., 1821D Winnemac Avenue, Chicago 40, Illinois. In Canada: The Holden Co., Ltd.

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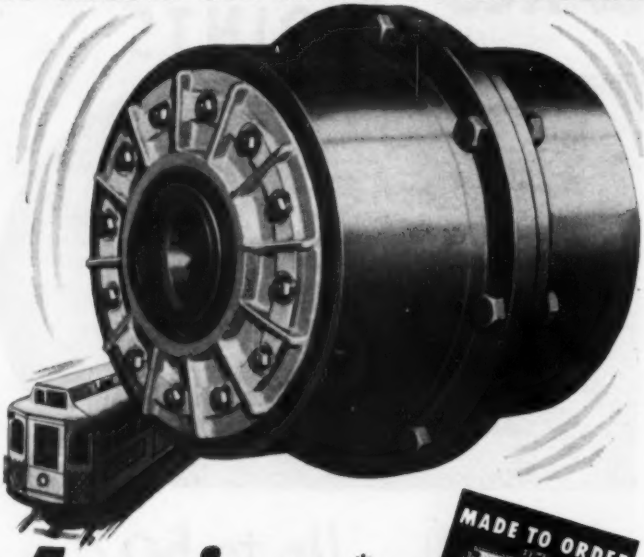
BARCO

THE ONLY TRULY COMPLETE LINE OF FLEXIBLE BALL, SWIVEL, SWING AND REVOLVING JOINTS

ENGINEERED...

TO SMOOTH OUT TRAVEL IN THE SUBWAY



Amerigear*

*Trade Mark Reg.

Special Traction Type Flexible COUPLING
Developed Cooperatively by the Train Builders Engineers and Amerigear Engineers

Detail of design of special traction type Amerigear Coupling. Consult Amerigear engineers for further information.

One of many special types of Amerigear Flexible Couplings derived from the standard type in which is incorporated a fundamental improvement in gear tooth design that achieves a remarkably higher efficiency in the transmission of power. This *proven gear type coupling* with fully crowned teeth *is being utilized in solving a wide range of special power transmission problems* other than those common to ordinary gear type couplings. Amerigear Power Transmission Engineers are available for consultation.

AMERICAN FLEXIBLE COUPLING COMPANY

Originator of the Amerigear Fully Crowned Tooth
Sales Offices in Principal Industrial Centers

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AFFILIATE OF J. A. ZURN MFG. CO.

Write on your Business Letterhead for further information regarding *Amerigear Couplings* with the *Fully Crowned Teeth* and Catalog 501.

Also Manufacturers of
The Original "Oldham Type" American Flexible Coupling

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Tubing Failures

The many factors affecting tube life in high-pressure, high-temperature applications are presented in a new 40-page illustrated booklet, No. TR516, published by the Tubular Products Div., of The Babcock & Wilcox Co., Beaver Falls, Pa. The booklet presents the results of a great number of investigations of failures of carbon steel, intermediate chromium-molybdenum alloy steel, and stainless-steel tubing in boilers, cracking stills, heaters, and heat exchangers during service at elevated temperatures and pressures in the power, oil, and chemical processing fields. It displays the history and experience behind the contemporary development of high-temperature tubing and will be of assistance to those in the field to obtain optimum failure-free service from their tubing installations.

Oscillating Conveyers

A new 24-page illustrated book, No. 2444, on Positive Action Oscillating Conveyers for conveying, feeding, cooling, screening a great variety of loose bulk materials, is announced by Link-Belt Co., Chicago, Ill. The book includes dimensions, weights, and capacity and horsepower charts on torsion mount oscillators for heavy-duty as well as for the recently announced Flexmount oscillator for the lighter-duty applications. Book shows the handling of shakeout sand, food products, cement clinker, metal chips, hot mineral sands, hot castings, silicon carbide and cullet. Among other bulk materials listed are coal, ores, chemicals, wood chips, etc. The trough widths of standard conveyers range from 8 to 48 in., and the handling capacities range from a few pounds to several hundred tons per hour.

Radiation Instruments

A new 8-page, 2-color bulletin No. GEA-5735, containing essential information on 10 recent nuclear radiation detectors is available from General Electric Co., Schenectady, N.Y. The illustrated booklet covers the G-E radiation monitor, scintillation counter, portable radiation probe, area health monitor, long-probe gamma survey meter, alpha hand counter, air equivalent ionization chamber, boron-coated counter tube, thermocouple vacuum gage, and the step-motor impulse counter. The instruments are designed for use in industry, hospitals, laboratories, and civil defense work.

Air-Conditioning Cabinets

An engineering bulletin published by Buffalo Forge Co., Buffalo, N.Y., describes the new Buffalo Model "G" air-conditioning cabinets. These central units are now available in both horizontal and vertical models in sizes from 875 to 22,000 cfm of conditioned air. Combinations may be had for any function or functions of air conditioning, including simple cooling, summer cooling and dehumidifying, winter heating and humidifying, and continuous air cleaning. All units may be equipped with an air washer section, as well as automatic controls, if desired. The new bulletin, No. 3703A, includes capacity tables, diagrams, charts, and detail photos to aid in the selection of the proper unit for given conditions.

Metric Equivalents

As a special service to the engineering trade The Frederick Post Co., Chicago, Ill., has compiled , and is offering, a combination Conversion and Decimal Equivalent chart. This chart converts inches to feet and metric equivalents all on one side. On the other side of this giant chart are the standard decimal equivalents. This fine chart is size 17 × 22 in. protected with tin at both top and bottom, ready for hanging.

Induction Heating

A new 12-page, two-color bulletin, No. GEA-5679, on equipment for induction heating is available from the General Electric Co., Schenectady 5, N. Y.

The booklet describes forging, hardening, brazing, and annealing applications at 1000, 3000, and 10,000 cycles. It explains the components and requirements of induction heating with motor-generator type equipment and also covers such applications as forge welding, heating drill bits, continuous heating of moving strip, and surface hardening.

Compacunits

Bulletin No. 242, 10 pages, illustrates and describes the complete line of Warren close-coupled and cradle-mounted pumps. Unusual features are illustrated and explained in detail. Dimensions, rating table, etc., are given. Available from Warren Steam Pump Co., Inc., Warren, Mass.

Tool Steel Handbook

Publication of "Tool Steel Handbook," a 197-page volume designed for engineers, teachers, metallurgists and others interested in tool, die, and allied steels, is announced by Allegheny Ludlum Steel Corp.

The handbook begins with charts and tables giving specific and comparative data on properties, analyses, and applications. This is followed by detailed descriptions of all important grades, arranged alphabetically for easy reference. Later chapters deal with the many forms and finishes of tool and die steels and such allied products as the sintered carbides marketed under the name of Carmet. Final sections are comprised of extensive discussions of heat-treating and handling techniques as applied to tool and high-speed steels and a complete set of weight tables and other useful reference material.

"Tool Steel Handbook" brings under one cover for the first time the combined data and technical information of Allegheny Ludlum and many of its customer companies. Free copies of the volume will be sent to qualified persons on request to Allegheny Ludlum Steel Corp., 2020 Oliver Building, Pittsburgh 22, Pa.

Polariscope

A new bulletin describing the dynamic polariscope is available from General Radio Co., Cambridge, Mass. It gives details of its usefulness for stress analysis.

Heat-Treating

Copies of the "Heat Treat Review," a periodical, are available from Surface Combustion Corp., Toledo, Ohio. Each issue contains reliable information on the latest processes and the most advanced fuel-fired equipment. The fourth issue, vol. 2, No. 2, which is now available, features such articles as Batch Furnaces for Continuous Production and Protective Atmospheres for Annealing Non-Ferrous Wire.

Automatic Regulating Valves

Bulletin No. 700, available from Spence Engineering Co., Walden, N.Y., features a large cutaway illustration of a typical Spence pilot-operated regulating valve with detailed explanations of five design features. In addition, a panel is devoted to showing how the control function of a Spence regulator can be changed by using a different sensitive pilot.

Industrial Air Compressors

Complete engineering data covering Cooper-Bessemer's Type-M Line of motor-driven compressors is now available in a new bulletin, No. M-65. Compressors described range from 250 to 1000 hp with standard two-stage units and 300 to 1000 hp with standard single-stage units. Write The Cooper-Bessemer Corp., Mount Vernon, Ohio.

Non-clogging air diffuser fabric, cotton or Fiberglas, in steel mesh framework.
Connection to air supply
Cadmium plated steel or stainless steel body

SIMPLE LOW-COST **BIN-FLO** AERATOR UNITS
KEEP BULK MATERIALS MOVING

Finely ground dry materials in storage often lose air content and pack or bridge, thus losing capacity to flow.

BIN-FLO units diffuse low-pressure air through such materials, preventing packing and maintaining or restoring natural flow.

Easily installed in chutes, bins, hoppers, etc. Can be automatically controlled by BIN-DICATOR bin level indicators. Low first cost; low operating cost. Used in many industries. Fully guaranteed. Send for folder.

BIN-DICATOR Bin Level Indicator

BIN-DICATOR—"The Eyes of the Bin" watches material levels automatically and reports to central control point. Send for free book.

NEW 20-PAGE BOOK FREE

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13946-W Kercheval Detroit 15, Mich.

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Before specifying or purchasing open steel flooring check these exclusive features of Blaw-Knox Grating...

1. SAFETY underfoot at all times assured by twisted steel cross bars.
2. STRENGTH that only rigid "one-piece" Electroforged construction can provide.
3. SECURITY—no wobble, tilt or rattle caused by loose or lost screws, nuts, bolts.
4. EASY to maintain and paint . . . no sharp corners to clog with dirt.
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For complete data on Blaw-Knox Electroforged Steel Grating and Stair Treads write for Bulletin 2365.

BLAW-KNOX DIVISION OF BLAW-KNOX COMPANY
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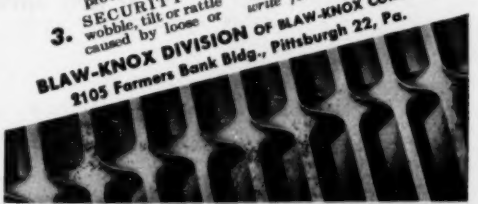


BLAW-KNOX *Electroforged*
STEEL GRATING & STAIR TREADS

Compilation of the

1953 ASME Mechanical Catalog

is now underway

Does your firm make a product which should be cataloged in the ASME Catalog?

Are your competitors represented in the ASME Catalog?

Is your Company represented?

If not, should they not be

?

The AMERICAN SOCIETY of MECHANICAL ENGINEERS

29 West 39th Street NEW YORK 18, N. Y.

When 3 draftsmen must do the work of 4—

Hamilton Auto-Shift tables are often the answer!

Exact drafting room productivity figures are difficult to develop, but in case after case we have been told that the *installation of Hamilton Auto-Shift tables increased production 20%, 30% and more.*

Impressive performance, and there are good reasons for it. Reasons like the instant, almost effortless adjustment of the Auto-Shift to any board position . . . and the sharp decrease in draftsman fatigue this brings about. Or the unique reference system utilized when Auto-Shifts are used in banks, and each unit furnishes a working-side reference surface for the next board in the bank. Or the simplicity and complete adequacy Auto-Shift offers for at-the-board conferences.

Like all Hamilton equipment, Auto-Shift tables are *work-designed* from a complete and intimate knowledge of drafting room operation and requirements. Available on reasonable delivery schedules, they offer you a solidly-built investment in increased productivity. *Be sure to get the complete Auto-Shift story from your Hamilton Representative soon.*

HAMILTON

DRAFTING EQUIPMENT

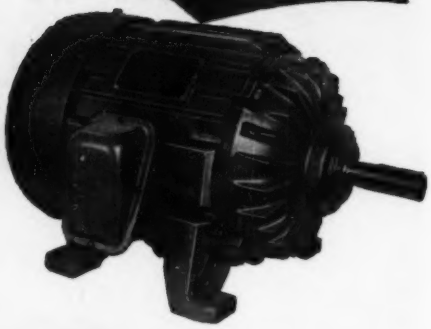
Hamilton Manufacturing Company

Two Rivers, Wisconsin

World's Largest Manufacturer of Professional Furniture

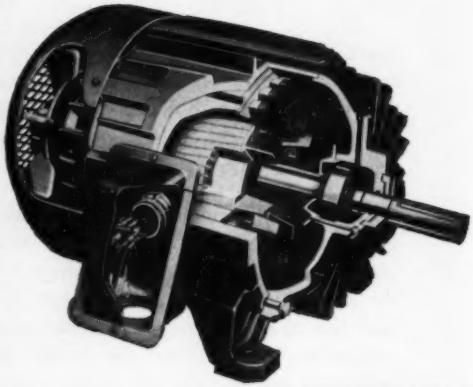
Totally-Enclosed Fan-Cooled

Look Outside



Greatly increased radiating area means greater cooling efficiency. More important, cooling efficiency stays high, regardless of operating conditions. There are no enclosed external air passages to clog and cause overheating. If oily dirt sticks, just wipe or blow it off. No matter how bad operating conditions are, this motor can be easily kept clean and cool running. Electrical parts are protected against corrosive atmospheres by cast iron yokes and end housings.

Look Inside



Double-shielded, heavy-duty ball bearings require no maintenance in ordinary service under most conditions. However, they can be lubricated without disassembly if required. Double shielding prevents over-lubrication, leading cause of bearing trouble. Rotating seals, where shaft extends through housings, keep dirt and moisture out of bearing chambers. Die cast rotor and interphase insulation are further assurance of long life and low maintenance.

See WHY THIS IS YOUR BEST MOTOR BUY

HERE IS A MOTOR that is different from conventional TEFC motors; built with an entirely different cooling system that gives you big savings in lower maintenance, more continuous service and less trouble in the toughest locations. Clogging can easily be prevented in the Allis-Chalmers Type APZ TEFC motor since areas that might collect dirt are exposed and easy to clean.

GET DETAILS NOW — *Ask your nearby Allis-Chalmers Authorized Distributor or District Office for more complete information on this high performance TEFC motor. Or write direct to Allis-Chalmers, Milwaukee 1, Wisconsin. Ask for Bulletin 51B7225.* A-3578

Texrope and Vari-Pitch are Allis-Chalmers trademarks.

Sold . . .
Applied . . .
Serviced . . .

by Allis-Chalmers Authorized Dealers, Certified Service Shops and Sales Offices throughout the country.

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.

TEXROPE — Belts in all sizes and sections, standard and Vari-Pitch sheaves, speed changers.

PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

ALLIS-CHALMERS

PIPING THAT MOVES

. . . calls for supports that are flexible

Grinnell Model L Constant-Support on 12-inch main steam at Somerset Power Station, Montaup Electric Co., Somerset, Mass. Pressure, 1300 psi; temperature, 930°F; load, approximately 4000 pounds. Note minimum headroom available.

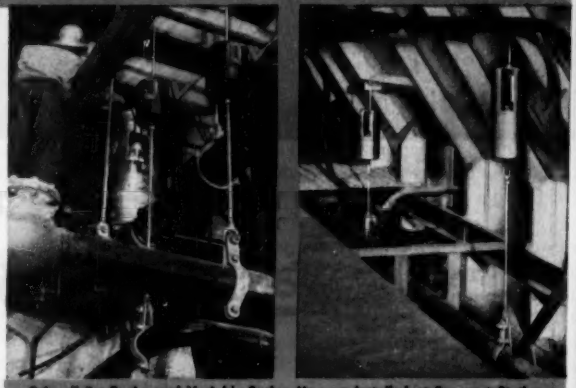
Thermal deflection of piping in today's high pressure, high temperature power stations necessitates flexible support of piping.

Where reactive forces at terminal points in a piping system must be kept within specified limits, constant-support type hangers are recommended. They are designed to provide substantially uniform supporting force equal to the pipe load throughout the travel range and should be used at superheater outlets, turbine connections, and also on high temperature and other critical lines.

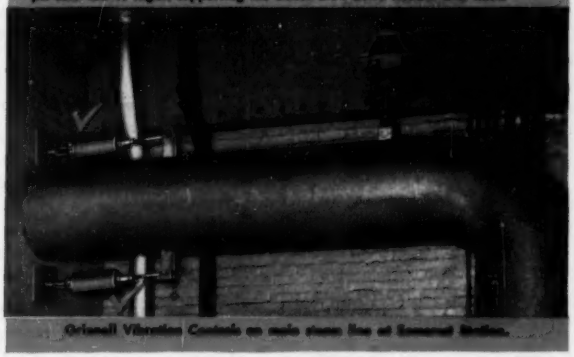
When pipe lines are subject to vertical movement and restrictive conditions do not require the use of a constant-support type, variable spring hangers are recommended. They should be designed to support not less than 85% or more than 120% of the designed load for the total travel.

When necessary to prevent abnormal movement or vibration in pipe lines, controls or sway braces of the energy-absorbing or instant-acting, counter force type are recommended.

Grinnell manufactures a complete line of engineered pipe hangers and supports; maintains a laboratory staff of trained technicians; provides highly skilled assistance and advice right from the design stage; and offers experienced field engineering service.



Grinnell Pre-Engineered Variable Spring Hangers installed at Somerset Station. Left: supporting boiler feed discharge lines, carrying steam at approximately 1785 psi and 455°F. Right: supporting the boiler blow-down header and lines.



Grinnell Vibration Controls on main steam line at Somerset Station.

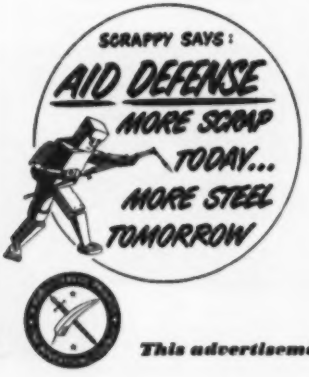
GRINNELL

AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPLIES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

Part of the Mesabi Range may be **wasting away** in your plant



Natural resources don't last forever . . . not even the Mesabi Range.

But *you* can make them last *longer* . . . by helping to recover the *dormant* iron and steel wasting away in your plant.

Right now, more iron and steel *scrap* is needed than ever before to help maintain steel production. Lack of enough scrap—which normally represents 50% of the ingredients used in making new steel—would seriously hamper the nation in this critical period.

WHAT *YOU* CAN DO

To meet demands of military and civilian production, *your* help is needed. That means searching *your* plant for *more* scrap . . . any old idle iron and steel gathering dust and rust.

Your scrap is needed *now*.

Get *your* scrap salvage program going—*today*. Include non-ferrous scrap, too.

It tells how to conduct your own salvage program

For your copy, write to Advertising Council, 25 West 45 Street, New York 19, New York

This advertisement is a contribution, in the national interest, by

MECHANICAL ENGINEERING

AFTER YEARS OF WEAR AND TEAR

Drawings are reclaimed without costly retracing

A case history based on the Buffovak Equipment Div., Blaw-Knox Corp., Buffalo, N. Y.—leading manufacturer of chemical and food processing equipment.

When any one of the 80,000 odd drawings in the Buffovak files is incapable of producing the sharp, clean blueprints needed for use in the shop . . . there's no redrafting problem.

"New drawings" are made from old ones—quickly, inexpensively with Kodagraph Autopositive Paper.

This revolutionary photographic intermediate material intensifies weak line detail, drops out stains, creases . . . produces fast-printing duplicate originals with dense photographic black lines on a durable, evenly translucent white paper base.

And the job's done at low cost because "Autopositive" is unique—a photographic paper that can be handled in ordinary room light . . . that produces positive copies directly—without a negative step. Also, it can be exposed in standard print-making equipment . . . processed in standard photographic solutions. *Convenience, economy*—from start to finish. And it's the same story in subsequent print production: Autopositive intermediates print back at practical, uniform speeds . . . and produce sparkling prints even after hundreds of "run-throughs."

Additional drafting time is saved in reproducing the prints which accompany customer orders. Extra detail must often be added before shop prints can be produced. So instead of redrafting, Autopositive intermediates are made . . . and then the new design is added to these print-making "masters." (If blueprints are received, they are reproduced on Kodagraph Repro-Negative Paper, which produces positive intermediates *directly* . . . and which is exposed and processed in same manner as Autopositive.)

Extra protection for Buffovak's more complicated and expensive drawings is obtained by reproducing them on Kodagraph Autopositive Cloth. This direct-to-positive printing photographic material produces extremely durable intermediates, which will remain intact year after year.

Kodagraph Reproduction Materials

"THE BIG NEW PLUS" in engineering drawing reproduction

Learn how Kodagraph Autopositive Paper is simplifying operations in thousands of drafting rooms. Write today for a free copy of "New Short Cuts and Savings" . . . interesting facts about companies you know . . . and a revolutionary new product *you should know.*

MAIL COUPON FOR FREE BOOKLET

16

EASTMAN KODAK COMPANY
Industrial Photographic Division, Rochester 4, N. Y.

Gentlemen: Please send me a free copy of your new illustrated booklet, "New Short Cuts and Savings."

Name_____ Position_____

Company_____

Street_____

City_____ Zone____ State_____

Kodak
TRADE-MARK

TWO TERRY TURBINES IN RECORD NON-STOP RUN AT CITIES SERVICE

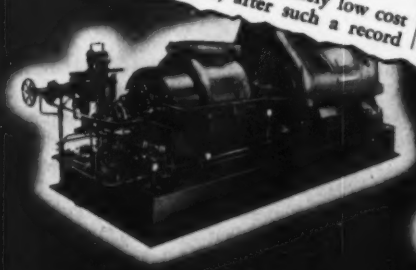
After 26 Months of Continuous Operation, Cost of Replacement Parts Only $78.00 for Each Turbine

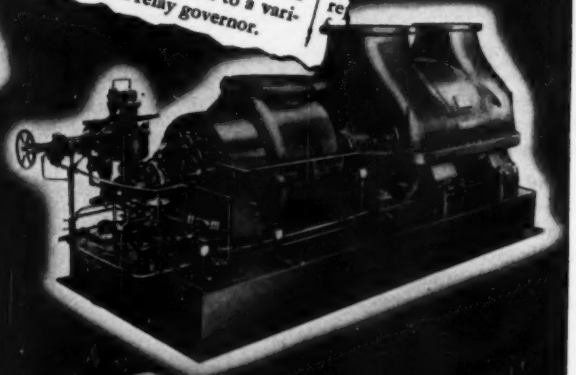
Two Terry turbines recently completed a record non-stop run at the East Chicago refinery of Cities Service Oil Company. Specially designed for driving air blowers on fluid catalytic cracking, they ran continuously *from initial start up*, day and night, for two years and two months. Throughout the entire run neither turbine suffered any noticeable reduction in efficiency.

On inspection, after shutdown, it was found that the only parts showing signs of wear were the shaft packing rings. These were replaced at a total cost of $78.00 for each turbine.

While this extremely low cost for repairs, after such a record run, could not have been anticipated, Cities Service had good reason to expect outstanding performance from Terry turbines. A four-year record of 216 Terry turbines at the Lake Charles refinery of this same company showed amazingly low maintenance costs. During this period, the yearly cost of replacement parts averaged only 1.4% of the initial investment.

The two turbines at East Chicago are rated 2450 horsepower at 5030 rpm. Each is equipped with a trip throttle valve, forced feed lubrication, and regulator for process control applied to a variable speed oil relay governor.





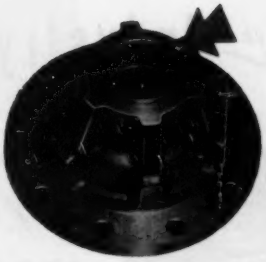
For more information about Terry multistage turbines, send for a copy of Bulletin S-146. No cost or obligation.

TERRY

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1193

AS A SHAFT . . . Rollpin serves as an axle for the sparkwheel of a cigarette lighter. No riveting or threading necessary . . . faster assembly. Note flush, clean fit.



AS A DOWEL . . . Rollpin is used here to prevent rotation of a thrust bearing. No reaming, no special locking. Easily removed. Lowest possible dowel pin cost.

AS A CLEVIS PIN . . . here Rollpin holds firmly in clevis, permits free action of moving member. Rollpin application above is with the plate of a home workshop tool.

AS A KEY . . . Rollpin demonstrates its ability to do away with precision tolerances, in this heating system damper arm. Faster, cheaper and more satisfactory than usual assemblies.

AS A STOP PIN . . . in this application, Rollpin is shown in a ratchet wrench adaptor. With its light weight and high shear strength, Rollpin functions perfectly . . . cuts assembly costs.

AS A SIMPLE FASTENER . . . Rollpin replaces a set screw in pinning a gear to a shaft. Assembly time is shorter, service life longer. Vibration-proof flush fit. Easily removable.

YOUR IMPORTANT FASTENING JOBS

are cheaper . . . faster, with ROLLPIN TRADE MARK

Rollpin is a pressed-fit pin with chamfered ends. It drives easily into holes drilled to normal tolerances, compressing as driven. No reaming, no tapering, no extra assembly steps required. Rollpin fits flush, *locked* in place by the constant pressure it exerts against the hole walls. Can be inserted with automatic press, or by hand—removable with a drift or pin punch.

Rollpin is reusable again and again.

Elastic Stop Nuts with the famous red collar are another ESNA product

MAIL COUPON TODAY. If your present operations or plans include the above applications—or set screws, rivets, hinge pins, cotter pins, pivot pins, taper pins—you can't afford to be without complete details on Rollpin. Write now—find out how much faster and cheaper Rollpin can do the job.

Section R1-311, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, N. J.

Please send me the following free information on ESNA self-locking fasteners:

☐ Rollpin bulletin and sample Rollpins ☐ AN-ESNA conversion chart
☐ Elastic Stop Nut Bulletin ☐ Here is a drawing of our product. What fastener do you recommend?

Name_____ Title_____

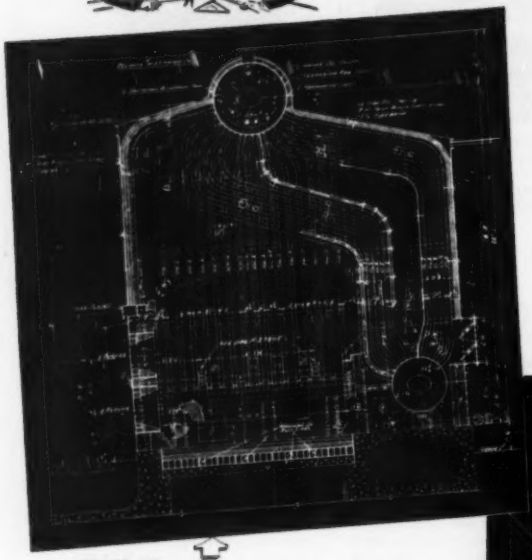
Firm_____

Street_____

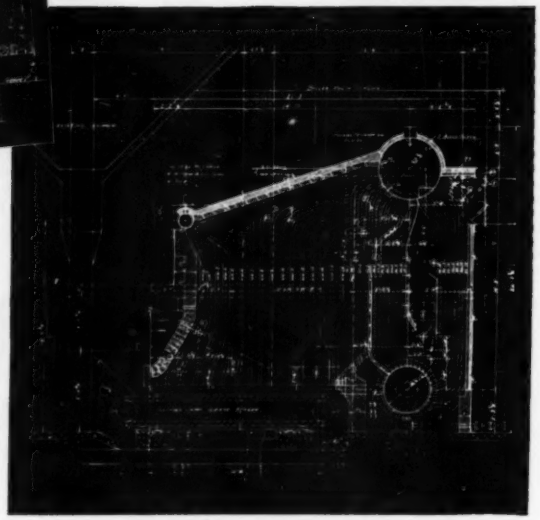
City_____ Zone____ State_____

Industry Approved

Two-Drum STEAM GENERATORS by Vogt



CLASS VF
A 22,000 pounds steam per hour unit installed at Indiana Farm Bureau Refinery, Mt. Vernon, Ind.



CLASS VS
The Seelbach Hotel, Louisville, Ky. is served by this 50,000 pounds steam per hour boiler.

A wide variety of industrial plants and other users of steam for power, processing, or heating have found these efficient Vogt Two-Drum Type Boilers to be the answer to their diverse steam generating requirements.

Class VF units provide maximum capacity in limited floor space and head room, while Class VS is best adapted to installations not having such restrictions. Each has a large furnace volume and a high ratio of radiant heating surface. The furnace design assures proper combustion of fuels fired in suspension or with various type of stokers.

A bulletin with general information and showing typical installations is available on request.

Typical Users...

FOOD PROCESSING PLANTS

DISTILLERIES • HOTELS

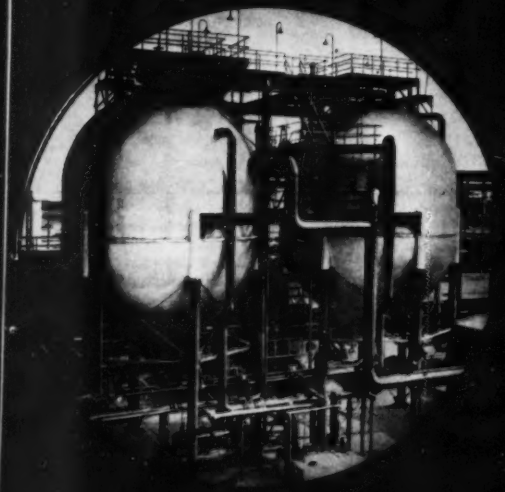
HOSPITALS • CHEMICAL PLANTS

PETROLEUM REFINERIES

HENRY VOGT MACHINE CO., Louisville 10, Kentucky

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

BIG "CATS" NEED GOOD WATER TOO . . .



Permutit two-stage hot lime soda and phosphate water softener recently installed at The Texas Company's Eagle Point Refinery.

WATER CONDITIONING HEADQUARTERS FOR 40 YEARS

—and Permutit Equipment brings it, at lower cost, to The Texas Company's new Eagle Point "cat" crackers . . .

The Texas Company, at their Eagle Point Works in Westville, N. J., processes 60,000 barrels of crude per day, in which processing modern fluid catalytic cracking is used. Over-all refinery steam and electric power balance dictated refinery boiler plant operation at 900 psi. Treated water is used on waste heat boilers on the cat cracker. They operate a Permutit two-stage hot lime soda and phosphate water softener to protect their boilers against scale and corrosion. Permutit equipment and its location are illustrated.

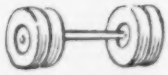
The Texas Company is but one of many concerns which realizes the value of proper water softening. To solve water conditioning problems, manufacturers in hundreds of industries have turned to Permutit. With 40 years of experience in water treatment, Permutit possesses the know-how to solve water conditioning problems economically at lower initial cost, with greater continuing savings.

For aid in the solution of your own water problems, write to The Permutit Company, Dept. ME-3, 330 West 42nd Street, New York 36, N. Y. or to Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

PERMUTIT

Bundyweld "Doodles"

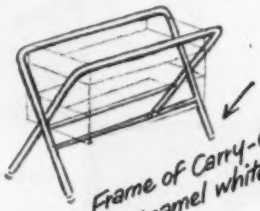
to jog a designer's imagination

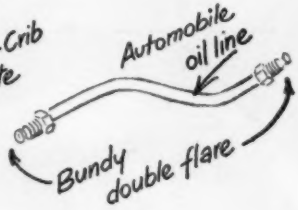


Toy truck axles

Redesigning to get better tubing function? Want smoother, easier fabrication? Need engineering help to crack tough tubing problems?

Then check into Bundyweld, the *only* tubing double-walled from a single strip, with inside and outside beveled edges. And check into the Bundy engineering services that have already helped hundreds of Bundy customers to save money, time, materials. Let us send you the information you need. ***Bundy Tubing Company, Detroit 14, Mich.***





Bundyweld® Tubing

DOUBLE-WALLED FROM A SINGLE STRIP

High thermal conductivity
High bursting point
Leakproof
High endurance limit
Extra-strong
Shock-resistant
Ductile
Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

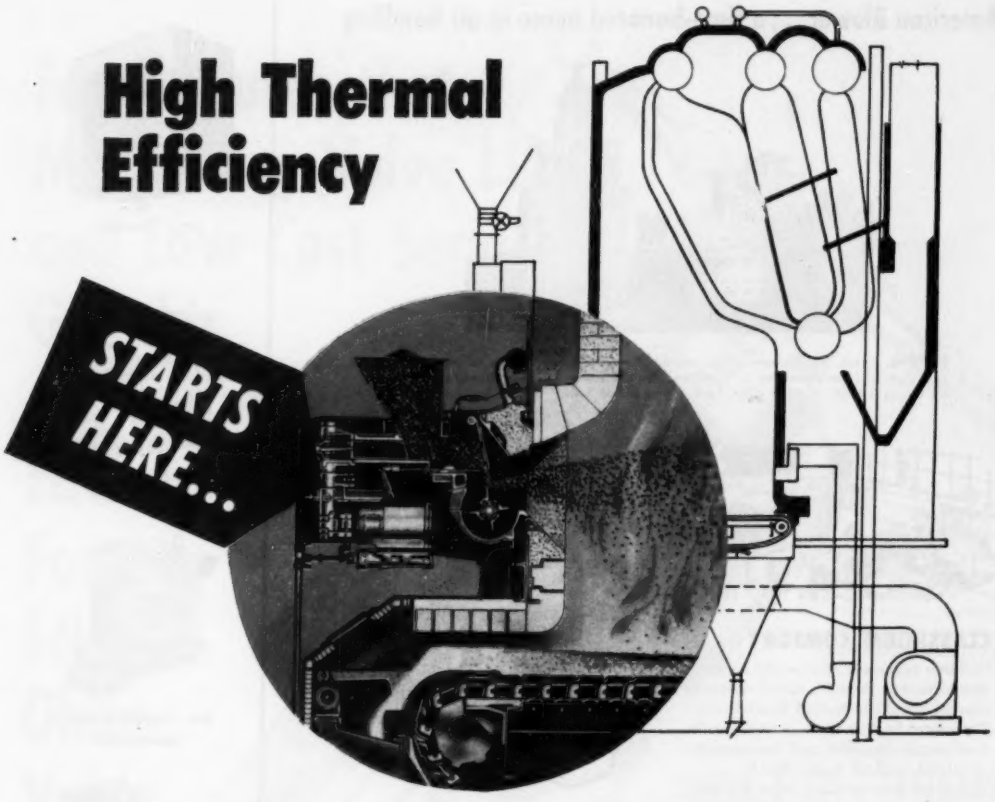
WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Presto . . . Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive patented **Bundyweld** beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: Cambridge, 42, Mass.: Austin-Hastings Co., Inc., 226 Binney St. • **Chattanooga 2, Tenn.:** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • **Chicago 32, Ill.:** Lapham-Hickey Co., 3333 W. 47th Place • **Elizabeth, New Jersey:** A. B. Murray Co., Inc., Post Office Box 476 • **Philadelphia 3, Penn.:** Rutan & Co., 1717 Sansom St. • **San Francisco 10, Calif.:** Pacific Metals Co., Ltd., 3100 19th St. • **Seattle 4, Wash.:** Eagle Metals Co., 4755 First Ave. South **Toronto 8, Ontario, Canada:** Alloy Metal Sales, Ltd., 881 Bay St. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

High Thermal Efficiency



It pays to choose your stoker carefully!

The coal-burning efficiency of your stoker is the starting point of coal saving . . . because the coal is all burned by the stoker and the coal bill is your major operating expense.

The burning of fuel for steam generation has always been one of the most exacting jobs that a machine can be called upon to perform. A stoker must operate twenty-four hours a day, seven days a week, for periods of six months or a year without a shutdown. The interior parts are exposed to heat and corrosion, the exterior mechanism to dirt and dust. A forced shutdown of the stoker may mean curtailment of production and cost the user many times the price of the stoker.

For over 60 years Westinghouse has maintained a consistently high standard of performance, while developing ever improved stokers to keep pace with the increasing demands of industry. And to make this assurance doubly sure, Westinghouse maintains a staff of experienced combustion engineers in all principal cities to make periodic inspections and give prompt attention to any operating problems.

Before you invest, be satisfied you are buying the best stoker. Westinghouse offers a complete line of underfeed and spreader stokers for use with any boiler of your choice. Capacities range from moderate to over 400,000 lbs. of steam per hour. Get the full story. Call your nearby Westinghouse office . . . or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-50525

YOU CAN BE SURE...IF IT'S
Westinghouse
STOKERS

American Blower... a time-honored name in air handling

El Paso, Texas, has a conveniently located American Blower Office to provide you with data and equipment for air handling. You can reach American Blower in El Paso by calling 2-2646. In other cities, consult your phone book.

CLASSROOM COMFORT

Children in schools all over the country now learn their three R's in real classroom comfort, thanks to Nesbitt Syncretizers. For winter heating fresh air is drawn in from outside, warmed, and continuously circulated without drafts. Result . . . rooms are more pleasant, more inviting. Available with or without matching storage cabinets, Nesbitt Syncretizers are gracefully styled to complement any schoolroom.

HEAT WITH GAS?

If you heat with gas and your present heating system is inadequate or inefficient, replace or supplement it with American Blower Gas-Fired Unit Heaters. They're built for long, hard service, are finished to harmonize with modern interiors. A.G.A.-approved, American Blower Gas-Fired Unit Heaters are designed for either manufactured, mixed, natural or liquefied petroleum gases.

MORALE BUILDER

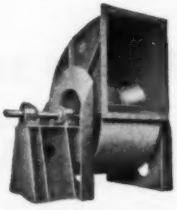
Good food and a pleasant atmosphere just naturally go together. Many firms, with employee cafeterias, use American Blower Utility Sets to keep kitchens and dining areas well ventilated. The Utility Set is ideal for general ventilation where duct systems are required. It can be used as a supply or exhaust fan and is equipped with Aileron Control for regulation of airflow. They're available as standard packaged units ready for immediate installation.

Whether your needs are civilian or military, American Blower heating, cooling, drying, air conditioning and air handling equipment improves over-all comfort and efficiency. For data, phone or write our nearest branch office.

Unit Heaters

Ventura Fans

Air Conditioning Equipment



Industrial Fans

Utility Sets

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary corporation

YOUR BEST BUY **AMERICAN BLOWER** AIR HANDLING EQUIPMENT

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • ACME CABINETS • CHURCH SEATS • DETROIT LUBRICATOR • KEWANEE BOILERS • ROSS HEATER • THERMANSAS IRON

For Features that Mean Long Valve Life and Low Cost Service Get this ALL-Purpose Edward Forged Steel Globe Valve

Edward Fig. 444-448 series, built in sizes ¼ to 2 in. inclusive . . . forged steel globe and angle . . . 600 and 1500 lb sp . . . bolted or union bonnet . . . screwed or socket welding ends . . . Fig. 448 illustrated.

Big CHECK THESE FEATURES

- ✓ Hard bronze yoke bushing to prevent stem seizing or galling . . . lock welded to yoke
- ✓ Packing is Edward EValpak . . . heat resistant, water-proofed and die molded for long service
- ✓ Disk of EValloy 13% chromium or Stellite . . . slotted or disk nut type . . . self centering
- ✓ Tight, easily accessible bolted or union bonnet joint . . . with ironkote gasket of 90 Brinnel max. hardness for leak-proof joint
- ✓ Heat treated forged steel inclined stem globe type body for lowest pressure loss
- ✓ Built-in pressure-tight backseat . . . permits repacking under pressure
- ✓ Roomy forged yoke . . . plenty of finger space for repacking
- ✓ Strong forged gland bolts . . . plated for long thread life

Edward Valves, Inc.
1350 West 145th Street, East Chicago, Indiana

Please send literature covering your Fig. 444-8 series all-purpose forged steel valves.

Name_____

Company_____

Position_____

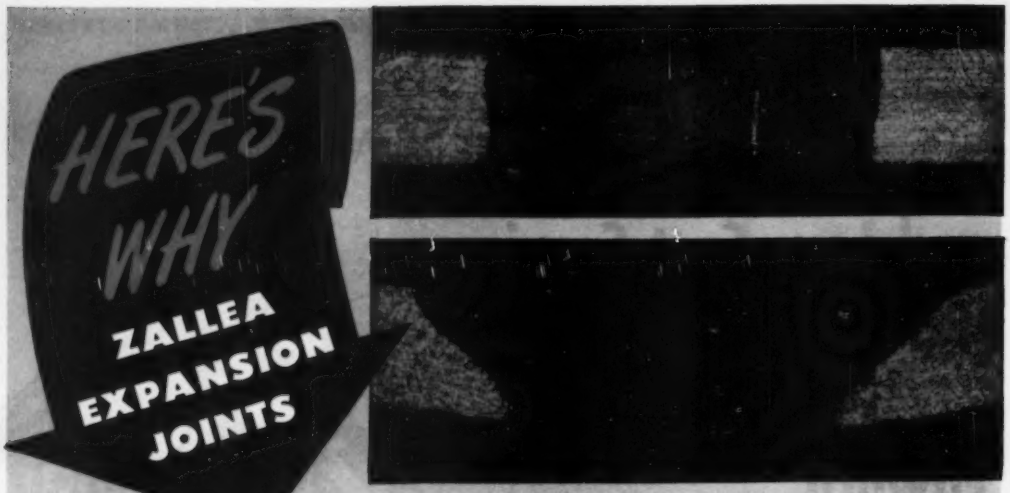
Address_____

City_____ Zone____ State_____

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA



Top: Weld bead of Zallea Expansion Joint.
Bottom: Weld bead of competitive expansion joint.

...Offer You Longer Service Life!

For years, expansion joint manufacturers have talked in general terms about "quality", "dependability", "economy", and the like. But these words have no real meaning to you as a user of expansion joints unless they are backed up by facts... and conclusive proof!

When we point out that Zallea Expansion Joints offer you *longer* service life, here's what we mean:

It's an accepted fact that the life of a corrugated expansion joint varies inversely with the thickness of the metal. Therefore it is essential that a corrugated bellows have uniform thickness throughout. Only in Zallea Stainless Steel Expansion Joints are you assured of this optimum condition because Zallea alone produces a longitudinal weld of the same thickness as the parent metal without grinding.

Accelerated flexing tests of many corrugated bellows proved that the resultant welding bead of a shielded arc weld was detrimental to the life of the bellows because failure always occurred across the weld—thickest section of the bellows. Zallea metallurgists analyzed many welding processes and found that by adopting an exclusive variation of the Heliarc process and adding a grain refining procedure to the finished weld, they could produce a corrugated bellows that under brutal flexing tests to destruction, *failed in the parent metal only.*

In over 100 bellows tested with Zallea controlled welding, not one failure occurred within 30 degrees of the weld line. More important was the fact that these bellows lasted as much as *8 times* longer than bellows having a shielded arc welding bead! Compare these two unretouched photomacrographs. See for yourself why it is to your advantage to buy Zallea when you want the best in expansion joints. Zallea Brothers, 820 Locust St., Wilmington 99, Delaware.

For complete information on all Zallea Expansion Joints, write for Catalog 47. You'll also want a copy of Bulletin 351 for quick reference. Ask for it too!

Zallea
EXPANSION JOINTS

Short Cut to Better Bearing Performance

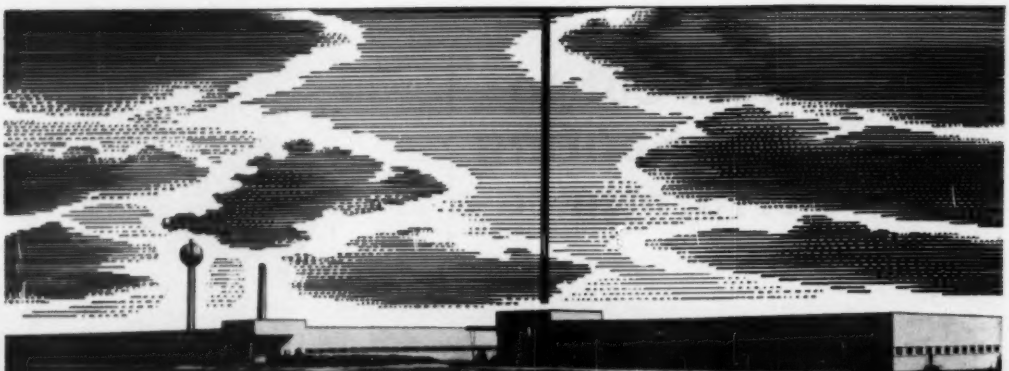
Single Pillow Block with Labyrinth Seal

If you are a manufacturer of fans and blowers or any other equipment where bearings are essential, you can often get the advantages of ball bearings without using "specials" that run up your costs. Here's how!

With Fafnir Standard Ball Bearing Units, you cut costs two ways: (1) the cost of the unit as compared with "Specials" and (2) the elimination of complicated machining and special housings. In addition, installation costs are pared way down because these units have the famous Fafnir Wide Inner Ring Ball Bearing with self-locking collar . . . makes adapters, sleeves and lock washers unnecessary. Seals keep lubricant in, dirt out. Now you know why we call these Fafnir units "Economy Packages".

Whatever your product or plant equipment . . . a few minutes spent with a Fafnir representative may bring forth an "Economy Package" that provides a short cut for you to the kind of performance only ball bearings can give.
The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA



design for water

Bank of Bush Water Coils in main duct. Note intermediate tie-bars, flanged top and bottom plates, drainage pal locks. Contractor — A. I. McFarlan, New York, N. Y.

Specialized air conditioning jobs as at Ortho Pharmaceutical Company's Manufacturing and laboratory Buildings illustrate the flexibility of Bush surface.

Here, in a combination well water and refrigeration job Bush Water Coils deliver leaving air at a temperature lower than the leaving water.

Something for nothing . . . ? No, merely special attention to water quantity . . . coil circuiting . . . proper ratio of prime to secondary surface in the coil construction.

If you're using water to heat or cool, check Bush coils or units today. Catalog 425 contains complete specifications.

No. 797—24-inch heavy duty electric motor operated valve. Handwheel for manual use in case of current failure.

No. 700—20-inch class "B" cast iron valve equipped with heavy duty handwheel control and threaded reach rod.

No. 627—Cylinder operated 60-inch heavy duty valve (either pneumatic or hydraulic control).

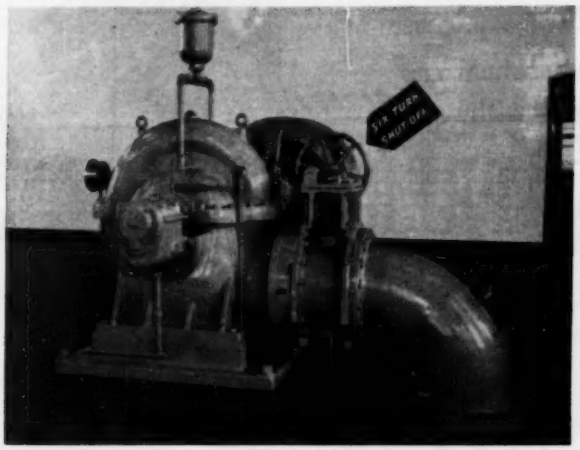
•

R-S Valves are synonymous with the simplified control and shut-off of any material that flows or is forced through a pipe, under a wide range of pressure and temperature.

•

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



ATLANTIC CITY *Simplifies* PUMP SHUT-OFF

New pumping units of the modern Atlantic City Pumping Station supplying water for this seashore resort are equipped with 125-pound handwheel operated R-S valves.

The valve illustrated above is closed in a matter of seconds (only six handwheel revolutions required) before the pump is started in order to prevent an overload on the pump and motor. The valve is then opened gradually and easily regulated according to demand.

Such valves can be equipped with hydraulic cylinders (tapped into the pipe line before and after the pump). As long as the differential pressure remains above a predetermined value, the cylinder will hold the valve open. Power or mechanical failure will cause a drop in the differential pressure, and the cylinder will close the valve automatically. Water hammer is impossible since the valve closes only as fast as the adjustable cylinder bleeds.

Specify R-S Valves for simplified construction and operation.

R-S PRODUCTS CORPORATION

4600 Germantown Avenue, Philadelphia 44, Pa.

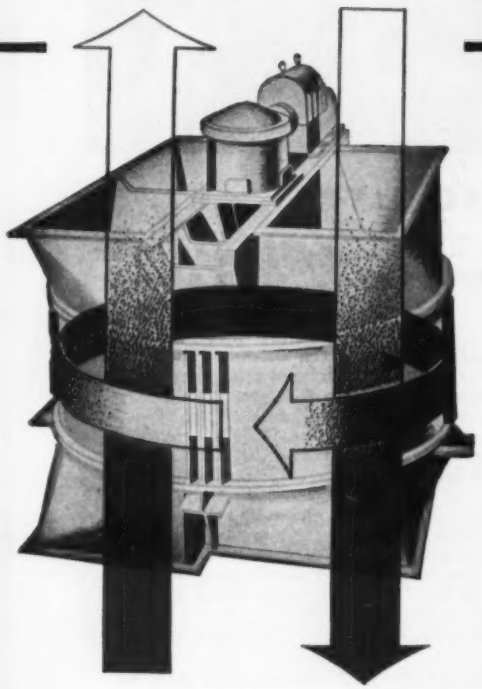
An S. Morgan Smith Company Subsidiary

DISTRICT OFFICES IN PRINCIPAL CITIES

more than 285,000,000 lb/hr of post-war steam generating capacity

equipped with *Ljungstrom*

AIR PREHEATERS



Here indeed is impressive evidence of the wide acceptance of the Ljungstrom air preheater. Since the war the total capacity of steam generating units equipped with Ljungstrom air preheaters, installed, under construction or on order in industrial and utility plants throughout the country comes to well over 285,000,000 pounds of steam per hour.

The reasons for the steadily increasing preference for the Ljungstrom air preheater are simple enough. The continuous regenerative counterflow principle assures maximum heat transfer with minimum weight and size. Flexible and compact, it may be used in a wide range of applications. Its proven reliability and low maintenance eliminate costly shutdowns.

If you are planning to build a new plant or modernize an old one, investigate the possibilities of the Ljungstrom. The specialized experience of Air Preheater engineers is at your disposal, to aid in effecting the most economic heat recovery from flue gases.

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

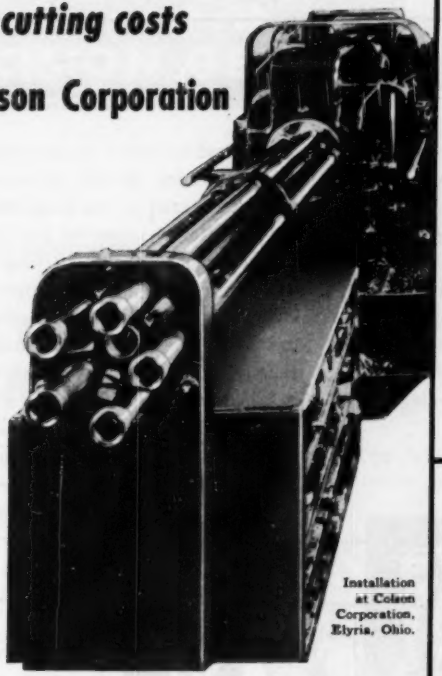
THE AIR PREHEATER CORPORATION

60 EAST 42d STREET • NEW YORK 17, NEW YORK

Warner & Swasey Automatics

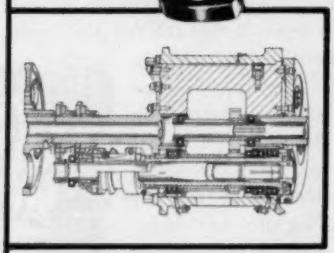
are cutting costs

for Colson Corporation



Installation at Colson Corporation, Elyria, Ohio.

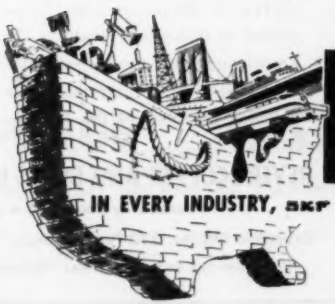
—and their 5-Spindle Automatic Bar Machines are SKF-equipped



Here's what Warner & Swasey designers did for one of their customers with advanced 5-spindle automatic bar machines • cut set-up time more than 50% • increased production 7 to 8 times on lots of 500 to 10,000 pieces • made "progressive" set-ups much more practical • made small lots economically practical • provided easy access and interchangeability of tooling • eliminated cam changing.

SKF Double-row Cylindrical Roller Bearings are used on front and rear locations. SKF Ball Thrust Bearings are adjacent to front Bearings. This design gives maximum rigidity through a variety of feeds and speeds without the need of bearing adjustment. Again, the teamwork of machine and bearing designers resulted in advance-designed equipment.

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.— *manufacturers of* SKF *and* HESS-BRIGHT *bearings.* 7325



SKF
BALL AND ROLLER BEARINGS

IN EVERY INDUSTRY, SKF Puts The Right Bearing In The Right Place

BUSINESS IN MOTION

To our Colleagues in American Business . . .

The Revere Technical Advisors call upon manufacturers from coast to coast, when requested to collaborate on special problems concerning the selection, fabrication or application of copper and copper alloys, and aluminum alloys. The procedure is this: the T.A. sits down with the customer or prospect, and together they study the project put before them by circumstances. It is a close collaboration, a joint effort that frequently results in marked improvement in quality or lessening of costs, or both. Here are some examples:

• Customer staking diamond inserts in free-cutting brass rod reported that the rod was turning color under the diamond, resulting in rejects. The brass was machined with a water-soluble oil, and cleaned with a special preparation. It was discovered that parts machined with sulphur-bearing oils were being cleaned in same container. This was the cause, and the obvious remedy eliminated discolor.

• Plumbing goods manufacturer was puzzled by the fact that brass tube purchased in small grain sizes for good plating qualities was giving both bending and plating troubles. Inspection of the processes of the manufacturer showed that the tube was being annealed with a torch before expansion and plating. This annealing resulted in a large grain size of .250 mm., as shown by a typical sample sent to the Revere Laboratory. Thus the apparent anomaly was explained, and close control of annealing was established to keep grain size within the necessary limits for satisfactory plating.

• An electrical manufacturer was using a very special and expensive copper alloy as a liner for a plunger housing. He felt this extremely hard alloy was necessitated by the large amount of wear on the part. Revere suggested that Herculoy, a silicon bronze, would be worth trying in hard temper. Tests were made, and the Revere alloy was found completely satisfactory. Substitution provides a metal that is more easily available, and at the same time costs less than the original.

• A maker of a timing device was having trouble blanking cleanly a small gear part. Detail was so fine and ratio of tooth height to width so great that leaded brass had a tendency not to form full teeth. A study of this problem brought forth the suggestion that a more ductile metal was needed, namely, ¾ hard cartridge brass. This worked beautifully when tried, and customer is extremely pleased with the tremendous reduction in rejects of this difficult part.

These are just a few of a number of cases that went into the "closed" file during a single month. Almost every other supplier to industry today does much the same sort of work with his customers. He feels it is not only a fine way to build good will, but also a part of his obligation to the customers who have helped him grow. It is a fact, of course, that every dollar you pay, whether for chemicals or metals, glass, cements, papers, carries a small charge for the research and know-how and skill required to make fine products. Your suppliers have knowledge you have helped pay for — why not use it as well as their materials? The results may be as pleasing as those in the four instances just cited.

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

Executive Offices: **230 Park Avenue, New York 17, N.Y.**

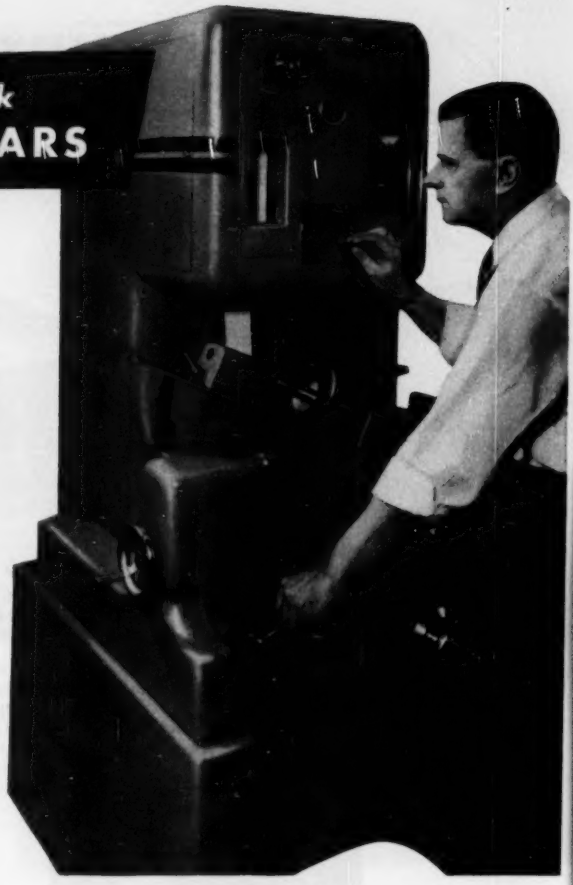
SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

How you can check
PRECISION GEARS

- ***quickly . . .***
- ***conclusively . . .***
- ***to closest tolerances***

with the

KODAK CONJU-GAGE GEAR CHECKER



Kodak Conju-Gage Gear Checker, Model 8U, tests gears up to 8½ inches in pitch diameter. Smaller models check gears up to 1¼ and 4½ inches, respectively.

To gear manufacturers and engineers faced with the problem of quantity production of tight-tolerance gears, a Kodak Conju-Gage Gear Checker provides the ideal solution.

It's fast—the production gear is quickly mounted and revolved against a Kodak Conju-Gage Worm Section. The composite effect of runout, base pitch and profile error, tooth thickness variations, and lateral runout is recorded automatically for ready, permanent reference. And a single Worm Section can be used for all spur or helical gears of any helix angle or any diameter, as long as they have the same normal pitch and pressure angle.

It's conclusive—Kodak Conju-Gage Gear Checkers conform to the composite gear-check principle recommended in the new American Standard, "Inspection of Fine Pitch Gears" (we'll send you a copy on request). It eliminates arguments or questionable rejection losses.

It's accurate—the inherent accuracy of the Kodak Conju-Gage Worm Section permits an exceptional order of precision, even in finer pitches. Specifications limiting tooth-to-tooth composite error to .0002" are easily met. Your own toolroom procedures can keep check on the accuracy of the gaging master. And, unlike circular masters, it can be reground to original specifications and precision, if necessary.

To find out more, send for your copy of the booklet, "Kodak Conju-Gage Gear Testing Principle." It's free, without obligation. Write to Eastman Kodak Company, Industrial Optical Sales Division, Rochester 4, N. Y.

CONJU-GAGE INSTRUMENTATION

. . . a new way to check gear precision in action

To inspect all kinds of complex parts on a bright screen, Kodak also makes two highly versatile contour projectors.

Kodak

Super-liner "UNITED STATES" will have "Shipshape" VENTILATION

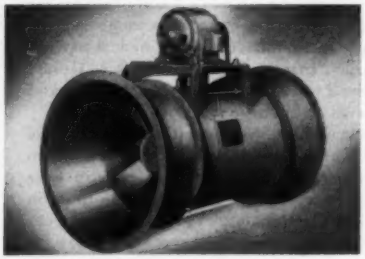
The 'United States' was constructed by Newport News Shipbuilding & Dry Dock Co., Newport News, Va.

OVER 200 "Buffalo" FANS ASSURE IT!

A king-size job for fans—supplying the ventilation for the largest American-built liner afloat, the 990-ft. "UNITED STATES"! Stale air is exhausted from entire decks. Machinery spaces, boiler rooms and engine rooms are ventilated. Enormous quantities of air must be supplied for ship-wide air conditioning services. And continuous air supply is needed to operate special Vortex cleaners designed for cinder elimination.

For these important jobs, "Buffalo" Fans were chosen exclusively—hundreds of them. The choice of these compact, durable, high-performance "Buffalo" Fans is thoroughly in keeping with the high standards set by United States Lines Company. If *you* are planning an air handling installation, plan it with "Buffalo" Fans, the make that leading firms specify.

Among the numerous "Buffalo" Type "LL" Fans used, many are larger than have been furnished by us for any passenger ship, and are used for exhausting discharged air high above the deck!



SPACE-SAVERS!
"Buffalo" Axial Flow Fans like this serve ventilating, heating, exhausting and air conditioning systems in the UNITED STATES.

FIRST FOR FANS

BUFFALO "Buffalo" FORGE COMPANY

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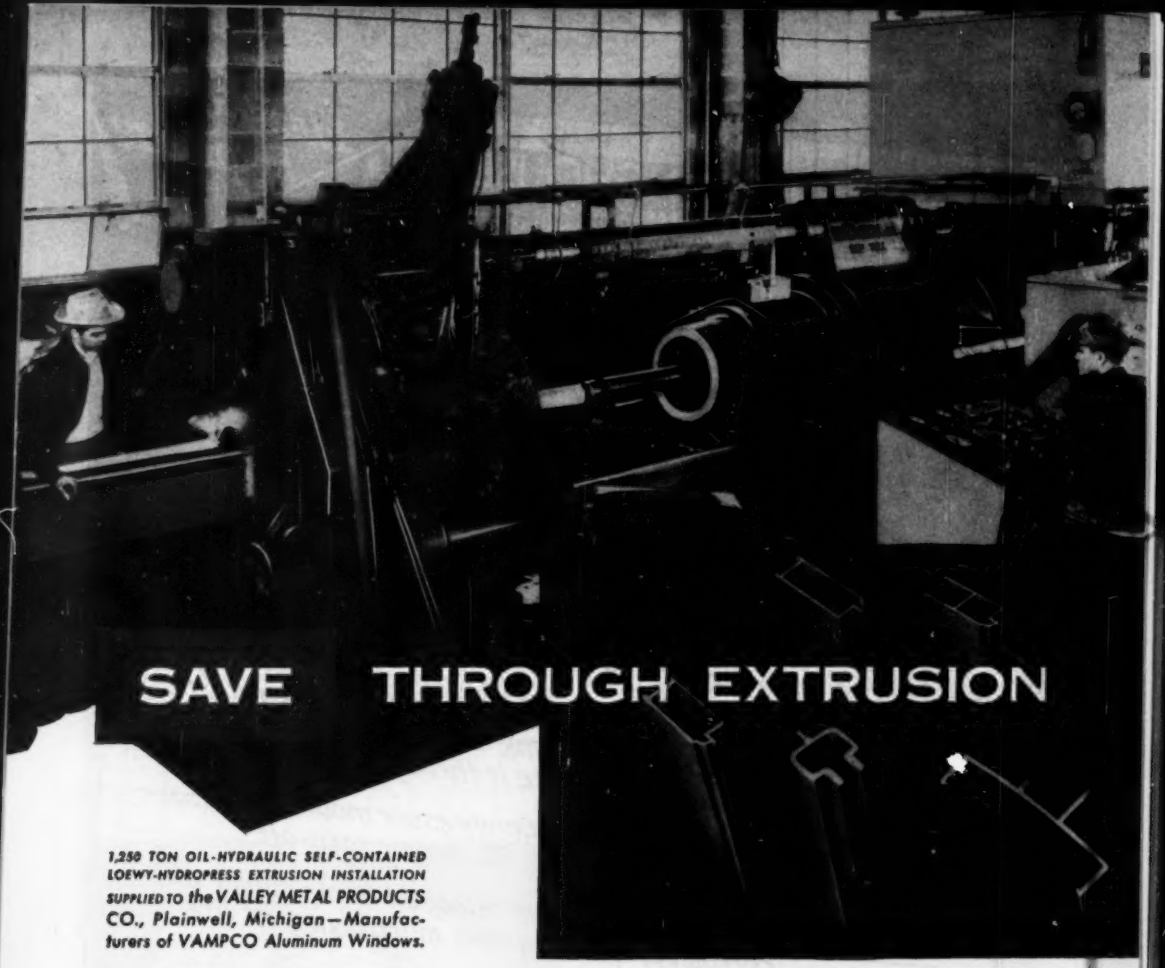
Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

VENTILATING FORCED DRAFT | AIR WASHING COOLING | AIR TEMPERING HEATING | INDUCED DRAFT PRESSURE BLOWING | EXHAUSTING



SAVE THROUGH EXTRUSION

1,250 TON OIL-HYDRAULIC SELF-CONTAINED LOEWY-HYDROPRESS EXTRUSION INSTALLATION SUPPLIED TO the VALLEY METAL PRODUCTS CO., Plainwell, Michigan—Manufacturers of VAMPCO Aluminum Windows.

[redacted] on equipment. A single Loewy-Hydropress installation rapidly and economically produces a wide variety of structural and ornamental shapes in light metals for the building, furniture, automotive and aircraft industries.

[redacted] space. No need to store supplies of extruded stock. A quick die change on a Loewy-Hydropress Extrusion Press produces the desired shape in quantity for immediate requirements.

[redacted] time. Transverse die slide cuts idle time between operations. This press design pioneered by Loewy-Hydropress, the result of years of experience, includes the latest improvements in the extrusion field.

CHECK THESE OUTSTANDING LOEWY-HYDROPRESS FEATURES • easy handling • simple design • full push button control • fast operation • high output • minimum personnel • small floor space • long stroke design giving space for easy loading of billets.

BUILT IN CAPACITIES UP TO 3000 TONS AND MORE

Write for details; please specify your requirements.

LOEWY HYDROPRESS

OIL-HYDRAULIC, SELF-CONTAINED EXTRUSION PRESSES

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INDUSTRIAL PRODUCTS DIVISION

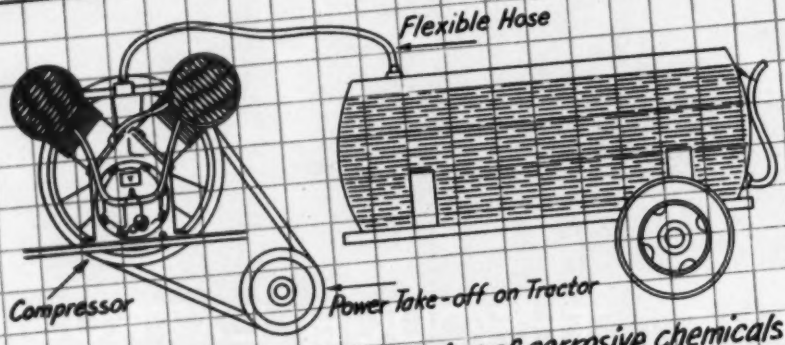
WESTINGHOUSE
AIR BRAKE COMPANY
WILMERDING, PENNA.

Ideas for Engineers

#8

Datair Sheet

EQUIPMENT: Chemical Tank Truck



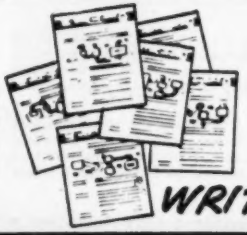
APPLICATION: Displacement pumping of corrosive chemicals by forcing air into tank and building up pressure above liquid to force it through discharge hose.

SOLUTION: Westinghouse SYC Compressor mounted on tractor and driven from its Power take-off.

RESULT: Pumping equipment removed from contact with corrosive chemical thus multiplying its life many fold.

So often AIR Solves the Control Problem!

In case after case, Plant Engineers are using W A B Pneumatic devices to solve control problems. The case presented above is an example. Our Engineering Data File provides information concerning this and many others. Sections of it may be applied to your problems. Write for a complete file. No charge.



FREE

THIS ENGINEERING DATA FILE

WRITE

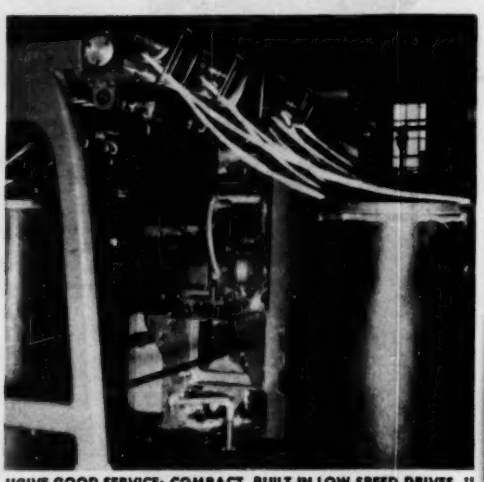
INDUSTRIAL PRODUCTS DIVISION

WESTINGHOUSE
AIR BRAKE COMPANY
WILMERDING, PENNA.

Factory Branch: EMERYVILLE, CALIF. Distributors throughout the United States . . . Consult your Classified Directory. Distributed in Canada by: Canadian Westinghouse Co., Ltd., Hamilton, Ontario.

THEY USE G-E GEAR-MOTORS FOR DEPENDABLE LOW-SPEED DRIVE

"G-E GEAR-MOTORS ABSORB SHOCK LOADS ON MIXERS . . . USED FOR 20 YEARS . . . GOOD SERVICE"
These stationary bowl mixers of Baker Perkins manufacture are used at the Lee Baking Company, Atlanta, Georgia. "Much power and low speed are required on these mixers where dough, bouncing around inside, increases the load on the gear-motor suddenly and violently . . . compact, efficient, the gear-motor design fits in very well, and we have used G-E gear-motors for twenty years with very satisfactory service," says Mr. H. K. Smith, engineer at Baker Perkins. Mixers shown here use 30/15 and 40/20 hp, two speed G-E gear-motors, which are built into the mixers.



"GIVE GOOD SERVICE; COMPACT, BUILT-IN LOW-SPEED DRIVES.."
G-E gear-motors give good service at an Eastern textile mill—working in an atmosphere kept at 60 per cent humidity and constantly filled with cotton fibers. Here a G-E gear-motor with a ratio of 6.25 to 1 drives the lap winder. Winders, taking the cotton after it has come from the "cards," and forming laps for use on "controlled draft drawing," must operate at a smooth, constant, low speed. Engineers also state the gear-motor provides a more constant rpm than they can obtain in any other way.

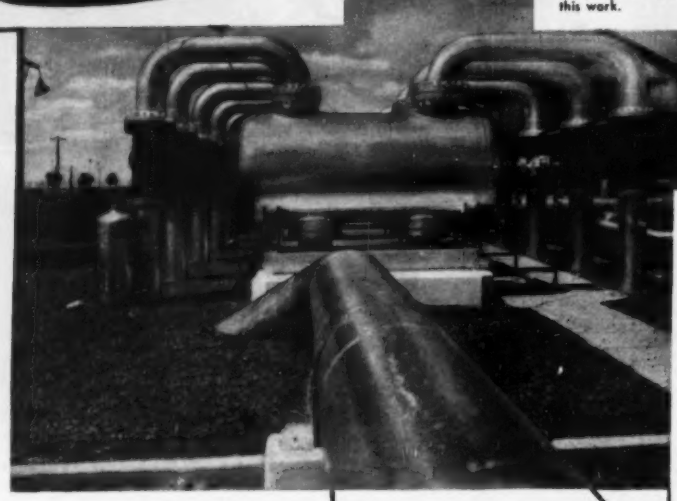
". . . DEPENDABLE . . . HAVE USED G-E MOTORS ALMOST EXCLUSIVELY FOR 40 YEARS . . ."
Kinney pumps are usually used on jobs requiring 24-hours a day, 6 or 7 days a week operation. Mr. R. C. Webster, General Sales Manager of Kinney states, ". . . gear-motors used must be dependable above all else. We have used G-E motors almost exclusively for 40 years all over the world. In our export business we find the customer specifically specifies G-E motors." Here a G-E gear-motor specialist discusses the application of G-E gear-motors on Kinney vacuum pumps with H. B. Neal, president, and H. R. Acres, G-E sales engineer.

Here are only three of the hundreds of applications for which reliable G-E gear-motors provide steady, low speed from a single compact unit. Where continuous processing, low steady speed, and severe duty cycles are encountered, G-E gear-motors have an outstanding record for long, dependable service. G-E gear-motors are standardized to minimize stocking of spare parts. They save much needed space because they are compact. They reduce hazards—often a drawback with line shafts and separate, unprotected gears. G-E gear-motors are available in 1 to 200 horsepower. For more information, write for bulletin GEA-1437 to Section 755-7, General Electric Company, Schenectady 5, N.Y.

GENERAL ELECTRIC

755-7

The large photo shows section of intake pipe and horizontal scrubbers on a large gas pipe line. One of the big tees (submerged in this installation) is inset below. Inset opposite is one of the big WeldELLS used in this work.



GUESS-WORK WON'T GO ON THE PIPE LINES

As the demand for oil and gas mounted, the pipe lines grew. The first growth was in number and miles; then in size and pressure. The use of larger pipe lines under higher pressure has hurled a challenge at the pipe designer. To hold down costs he must press further toward the yield point of pipe line materials . . . but never too near the danger point. Sound engineering is indeed required to insure safe operation under loadings that stress materials at 65% to 85% of their yield strength. There is no "margin for ignorance" here. You must *know!*

Recent Taylor Forge contributions to the pipe lines include improved designs of WeldELLS in large sizes and tees giving greater safety at branch connections... produced in materials whose strength matches or exceeds that of the tough API5LX pipe now being used in transmission lines.

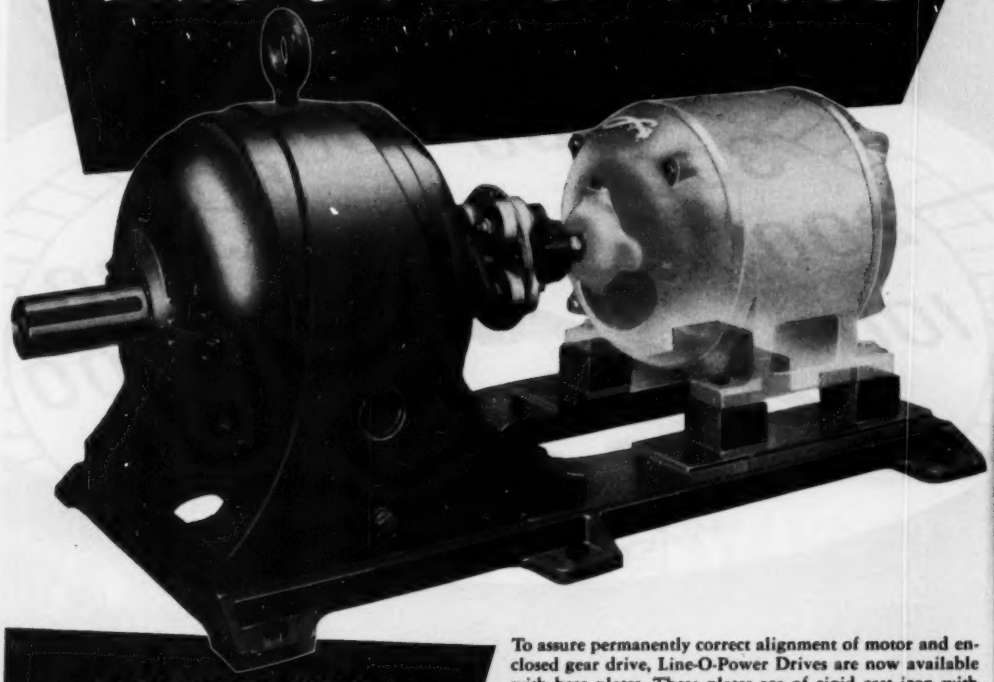
Ask for the facts about the WeldELL line of welding fittings and Taylor Forged Steel Flanges.

TAYLOR FORGE

TF WeldELLS®

TAYLOR FORGE & PIPE WORKS General Offices and Works: P. O. Box 485, Chicago 90, Ill. Offices in all principal cities. Plants at: Carnegie, Pa.; Fontana, Calif.; Hamilton, Ont., Canada.

Line-O-Power drives



PACKAGED WITH BASE PLATE AND COUPLING READY FOR INSTALLATION OF YOUR OWN MOTOR

To assure permanently correct alignment of motor and enclosed gear drive, Line-O-Power Drives are now available with base plates. These plates are of rigid cast iron with smooth surfaces and rounded corners, making an attractive installation. Their use assures rapid assembly of units and prevents misalignment of shafts.

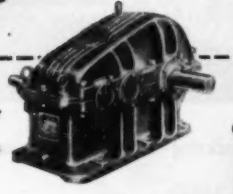
Faces of lugs on which unit and motor are mounted are precision machined, and bolt holes are accurately drilled and spaced.

Line-O-Power straight line helical gear drives with Duti-Rated high hardness gears offer economy in original cost and economy in operation. They are available with or without base plates for prompt delivery. Write for prices and complete information or see the Foote Bros. representative near you.

Foote Bros.-Louis Allis Gearmotors

FOOTE BROS.

Better Power Transmission Through Better Gears



Maxi-Power Helical Gear Drives

Hygrade Enclosed Worm Gear Drives

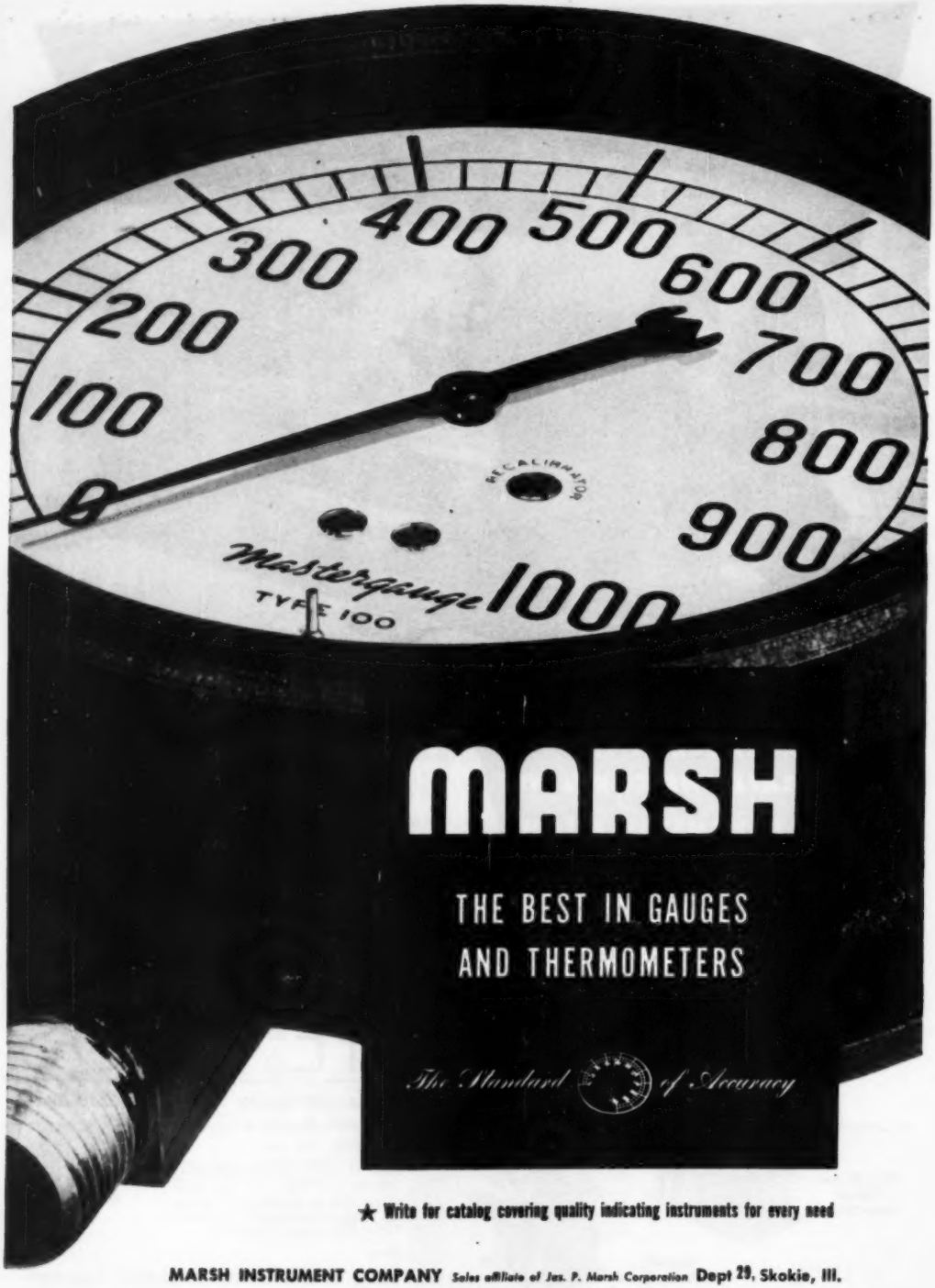
Foote Bros. Gear and Machine Corporation
Dept. Q, 4545 S. Western Boulevard
Chicago 9, Illinois

Please send me Bulletin LPC containing complete information on Line-O-Power Drives and base plates.

Name .....

Address .....

City ..... State .....



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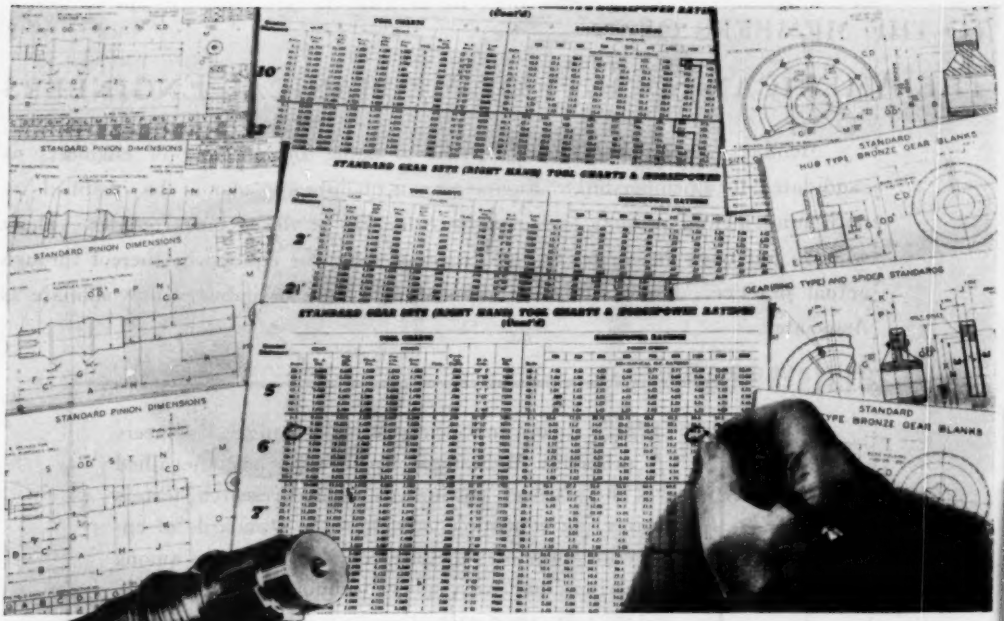
THE BEST IN GAUGES
AND THERMOMETERS

The Standard of Accuracy

★ Write for catalog covering quality indicating instruments for every need

MARSH INSTRUMENT COMPANY *Sales affiliate of Jas. P. Marsh Corporation* **Dept 29, Skokie, Ill.**
Export Dept., 155 E. 44th St., New York 17, N. Y.


STANDARD PINION DIMENSIONS
STANDARD GEAR SETS (RIGHT HAND) TOOL CHARTS & HORSEPOWER
STANDARD HUB TYPE BRONZE GEAR BLANKS
GEARING TYPE) AND SPIDER STANDARDS

plus this vital feature

Standard *Cone-Drive gears and worms are carried in stock. Cone-Drive gears are noted for their long life—BUT if a failure should occur at any time, replacement gears and worms are available without delay.*

Ask for Catalog No. 700

Specify STANDARD Cone-Drive Gears and get all these advantages

Lower Cost—due to smaller size of gears and housings, mass production of worm and gear blanks, etc.

Compactness—due to distribution of load over greater contact area, reducing unit pressures. As a result, gear sets can have smaller center distances, enclosures can be smaller, etc.

Less Weight—due to smaller center distances for a given horsepower or torque. Other types of gearing weigh up to 3 times as much for the same horsepower transmitted.

Greater Smoothness—because Cone-Drive gears have more teeth in continuous contact than other forms of gearing.

Wide Range of Sizes—Center distances from 2" to 18" provide horsepower ratings from fractional up to 800 horsepower. Ratios range from 5/1 to 70/1.

CONE-DRIVE GEARS *Division Michigan Tool Company*

DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS

7171 E. McNichols Road • Detroit 12, Michigan

TO THE MEMBERS OF———

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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ME-3-52

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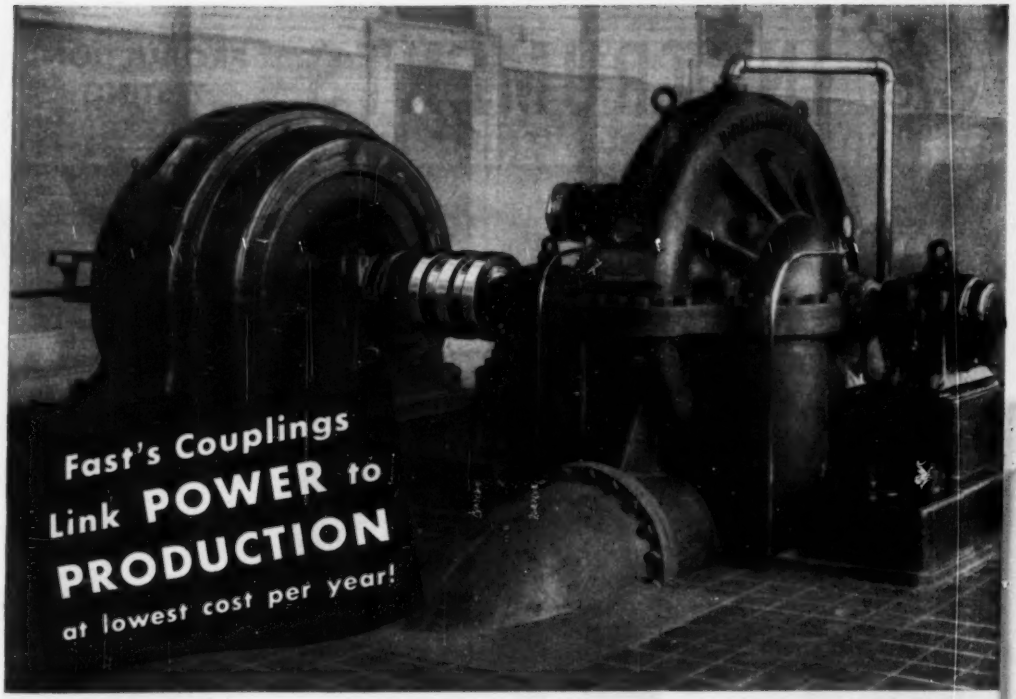

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605-8

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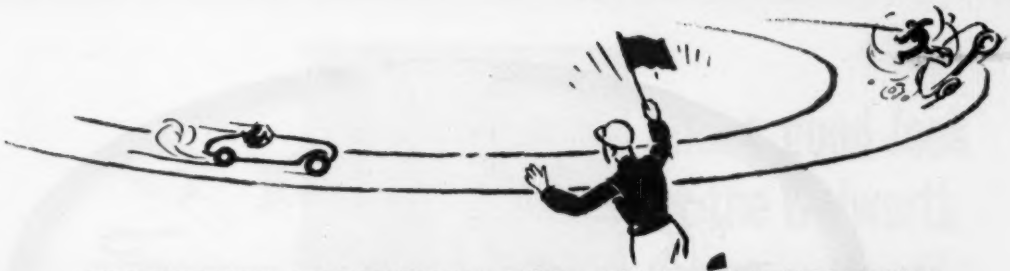

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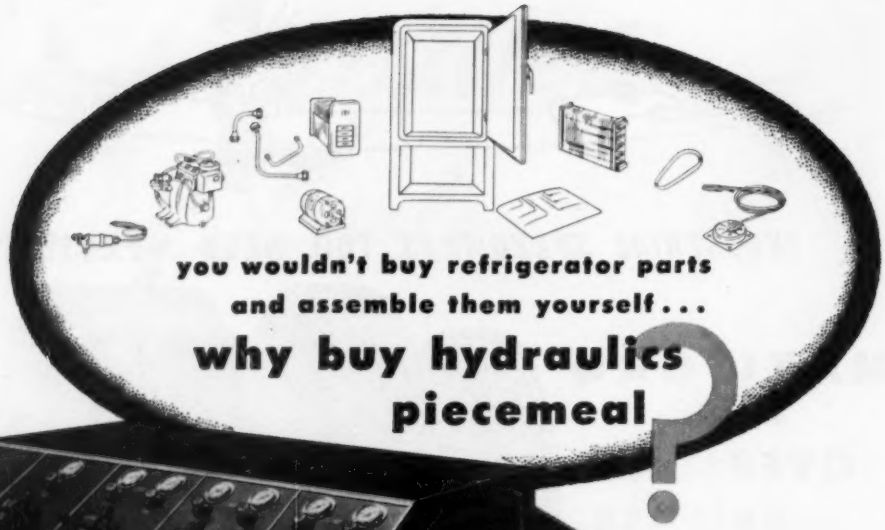

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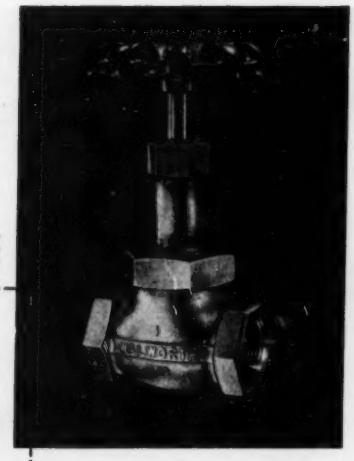

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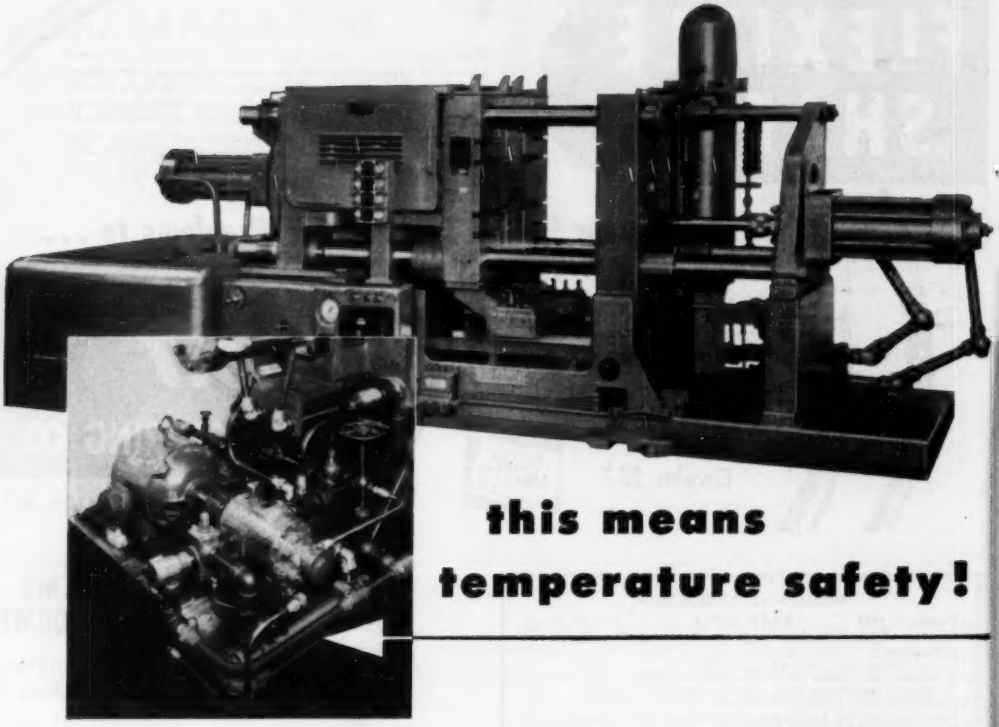

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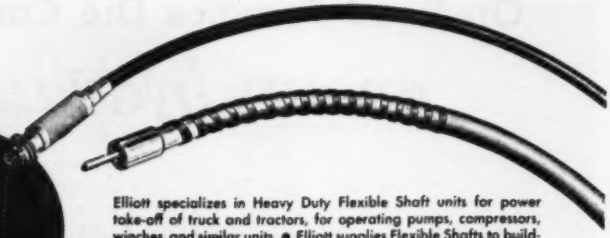

Elliott specializes in Heavy Duty Flexible Shaft units for power take-off of truck and tractors, for operating pumps, compressors, winches, and similar units • Elliott supplies Flexible Shafts to builders of Grinders, Sanders, Polishers, Concrete Vibrators and other portable tools for working in metals, plastics, wood and ceramics • Elliott manufactures Cores with windings and materials to suit every particular requirement, using the best grades of Full Music wire, Stainless Steel wire, or High Carbon wire . . . to fit the job.

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MECHANICAL ENGINEERING

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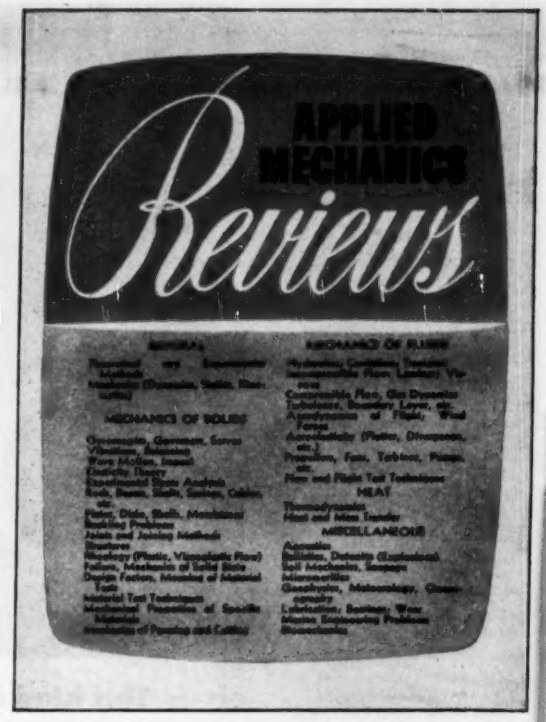

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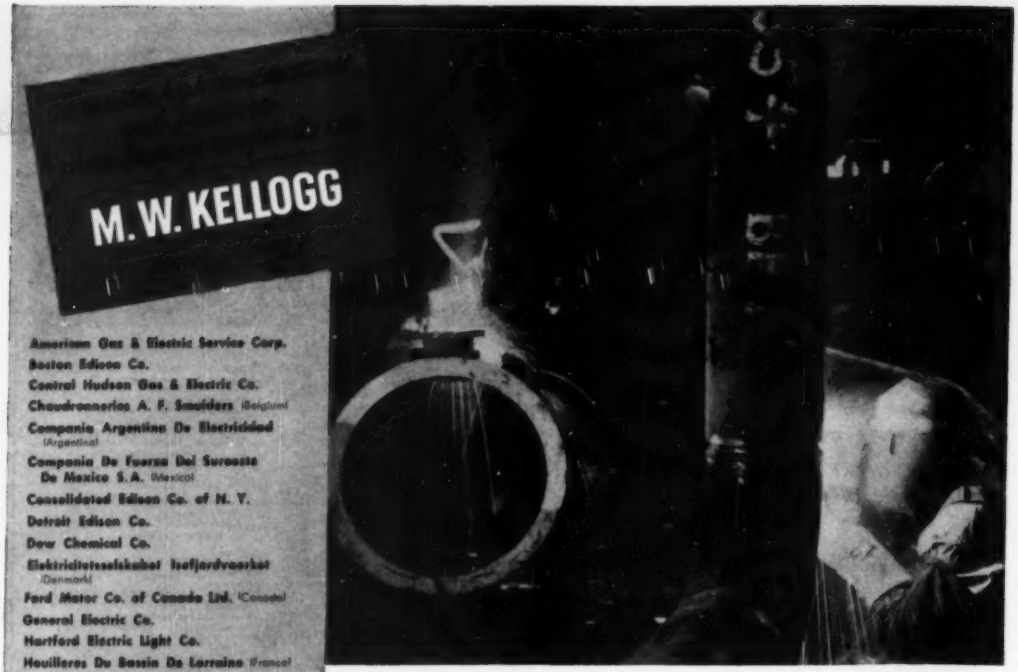

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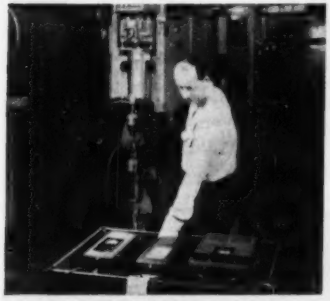

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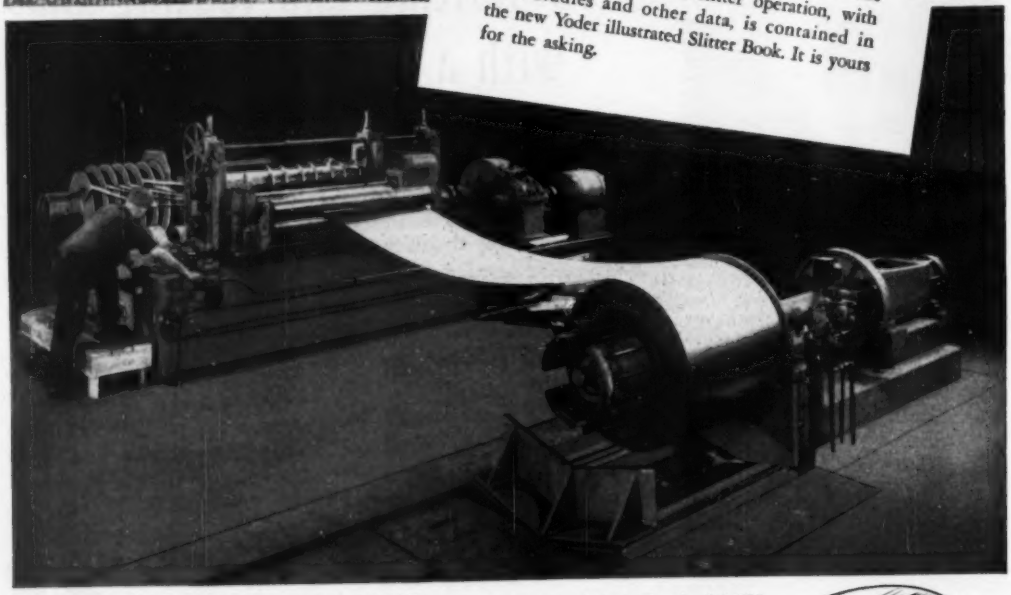

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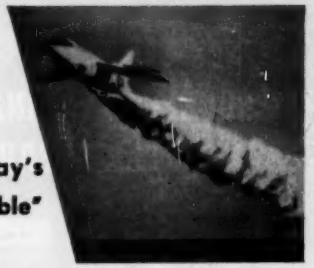

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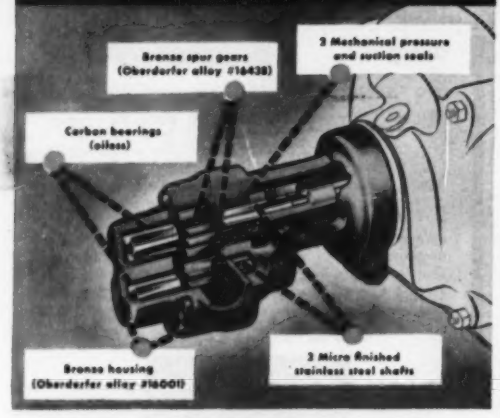
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*** 110 volt AC, Motor standard but specially machined for pump mounting.**

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25 lbs.	110 gal.	220 gal.
50 lbs.	100 gal.	190 gal.
75 lbs.	95 gal.	170 gal.
100 lbs.	90 gal.	——

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Pump No.	Height	Width	Length	Price
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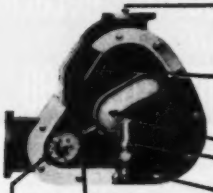

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DEFLECTOR prevents entering water from striking the float.

INSTANT RESPONSE is assured by large operating power obtained from leverage exerted by float buoyancy.

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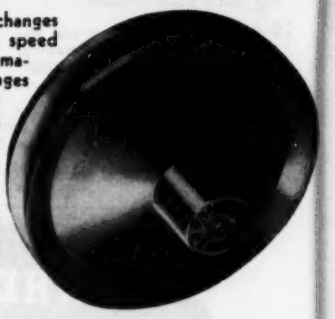

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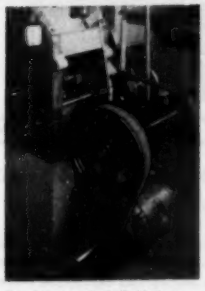

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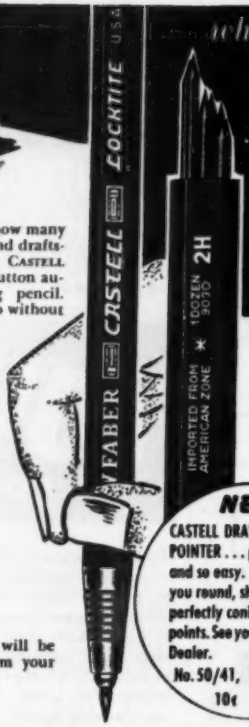

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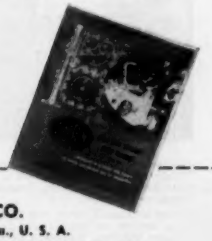

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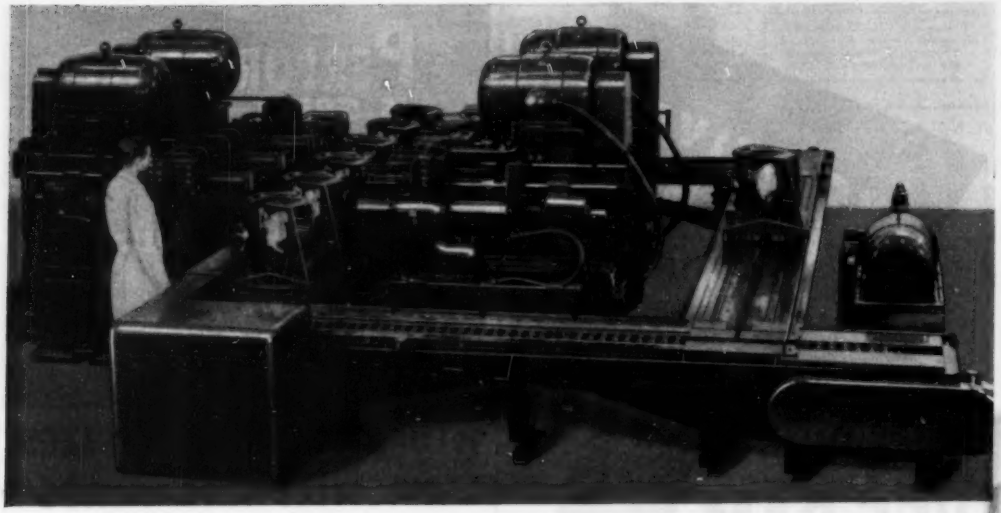

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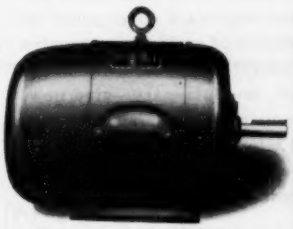

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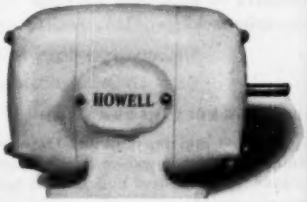

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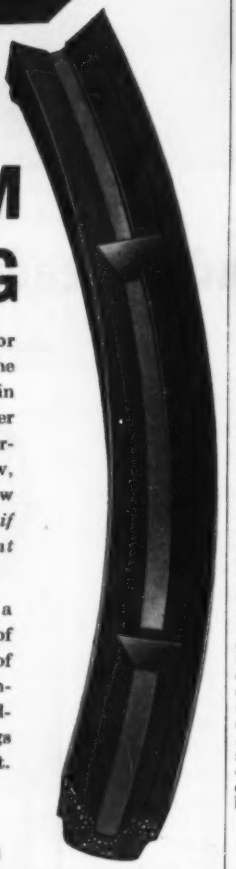

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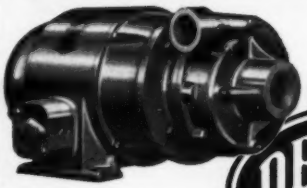

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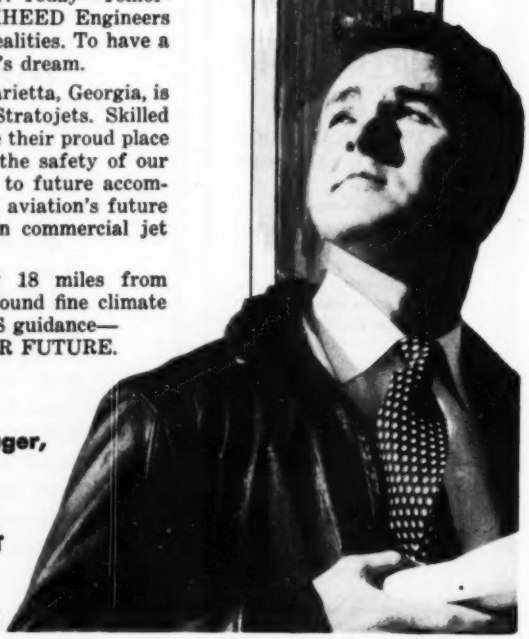

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SECTION 4

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Experience desirable but not essential.

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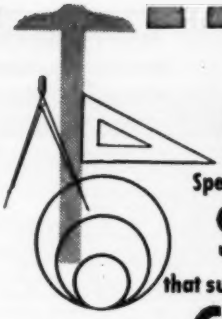

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"OPPORTUNITIES" Section This Month 125-131

POSITIONS OPEN

Continued from Page 130

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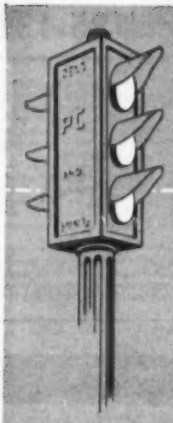

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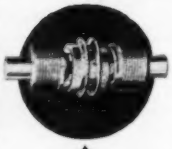

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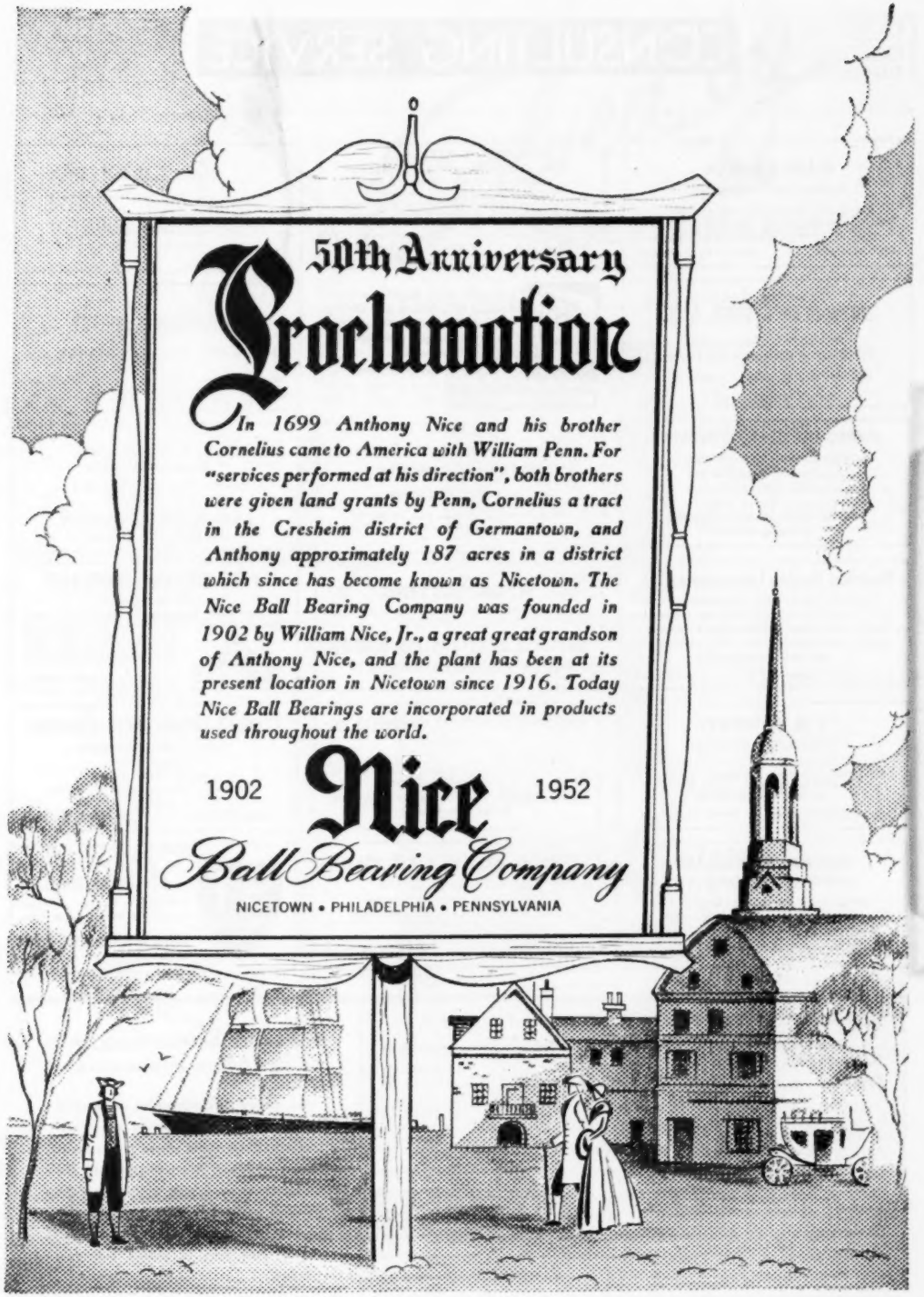
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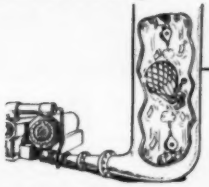
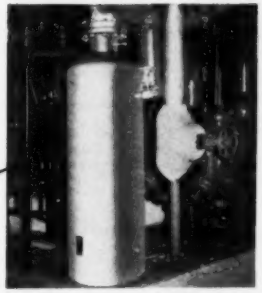


fluctuating fluid flow



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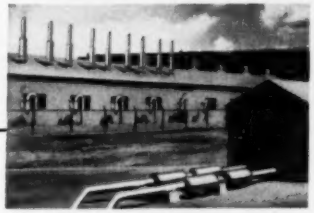

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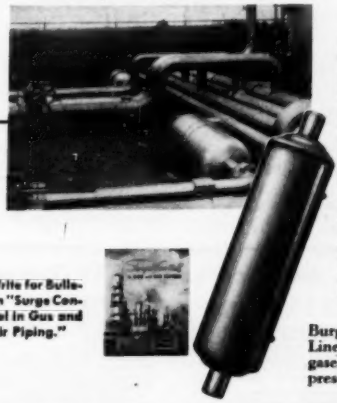

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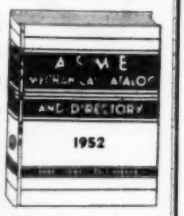

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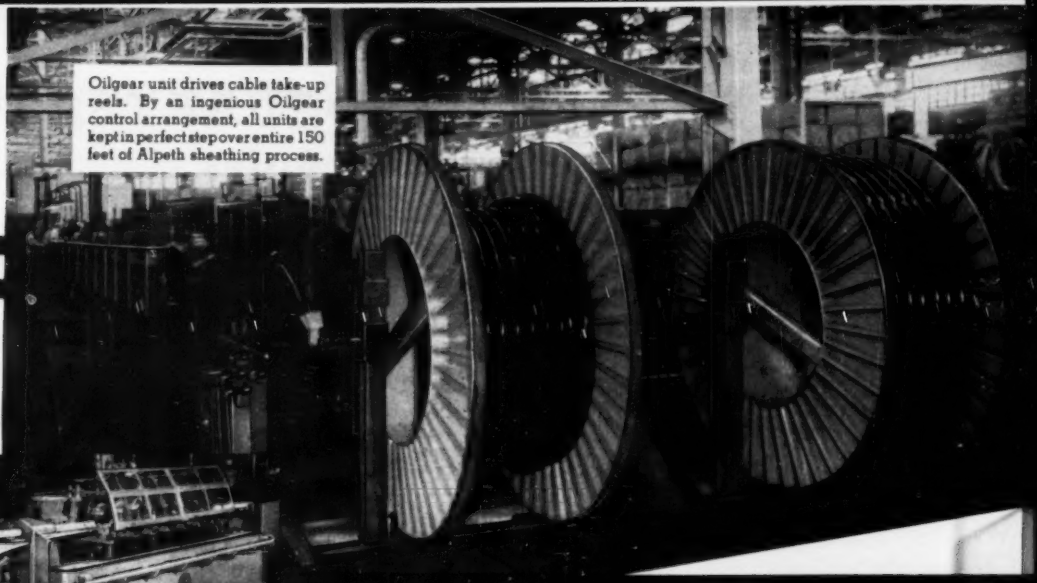
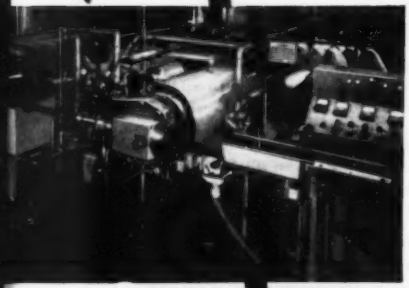


Oilgear unit drives cable take-up reels. By an ingenious Oilgear control arrangement, all units are kept in perfect step over entire 150 feet of Alpeth sheathing process.

WESTERN ELECTRIC'S

OILGEAR FLUID POWER

Oilgear fluid p[ower] drives Yoder roll forming machine which [shapes] corrugated aluminum sheathing arou[nd] cable.



Oilgear drive[s] synchronized to speed of Royle [extr]uder which covers cable with me[tal] polyethylene.

Tractor capstan powered by Oilgear, which pulls cable through extruder, long cooling trough and inspection station.

• Right after the war, the Bell System faced a tremendous problem because of the shortage of lead for sheathing telephone cable. To solve that problem, a newly designed sheath known as Alpeth—aluminum polyethylene—was adopted. And the engineers had to design a machine fast that would apply this sheath fast—to produce this new cable by the millions of feet.

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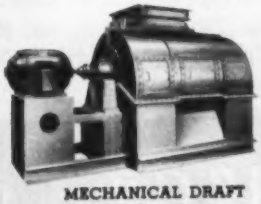

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CLARAGE FAN COMPANY—609 Porter St., Kalamazoo, Mich.

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Experience gained in producing the "Double-Zero" bearing is showing the way to greater and greater precision in *all* Timken tapered roller bearings. And this increased precision will mean greater bearing capacities, permitting the use of smaller bearings at lower cost. Just as today's standard bearing was the super precision bearing of a few years ago, the new "Double-Zero" bearing of today may well become the standard Timken bearing of tomorrow. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

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TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ⇕ AND THRUST →▯← LOADS OR ANY COMBINATION →✳←